Technical Memorandum No. 33-174

Tracking and Data Acquisition For Ranger Missions 1-5

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JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

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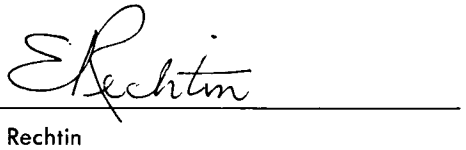

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ACKNOWLEDGMENT

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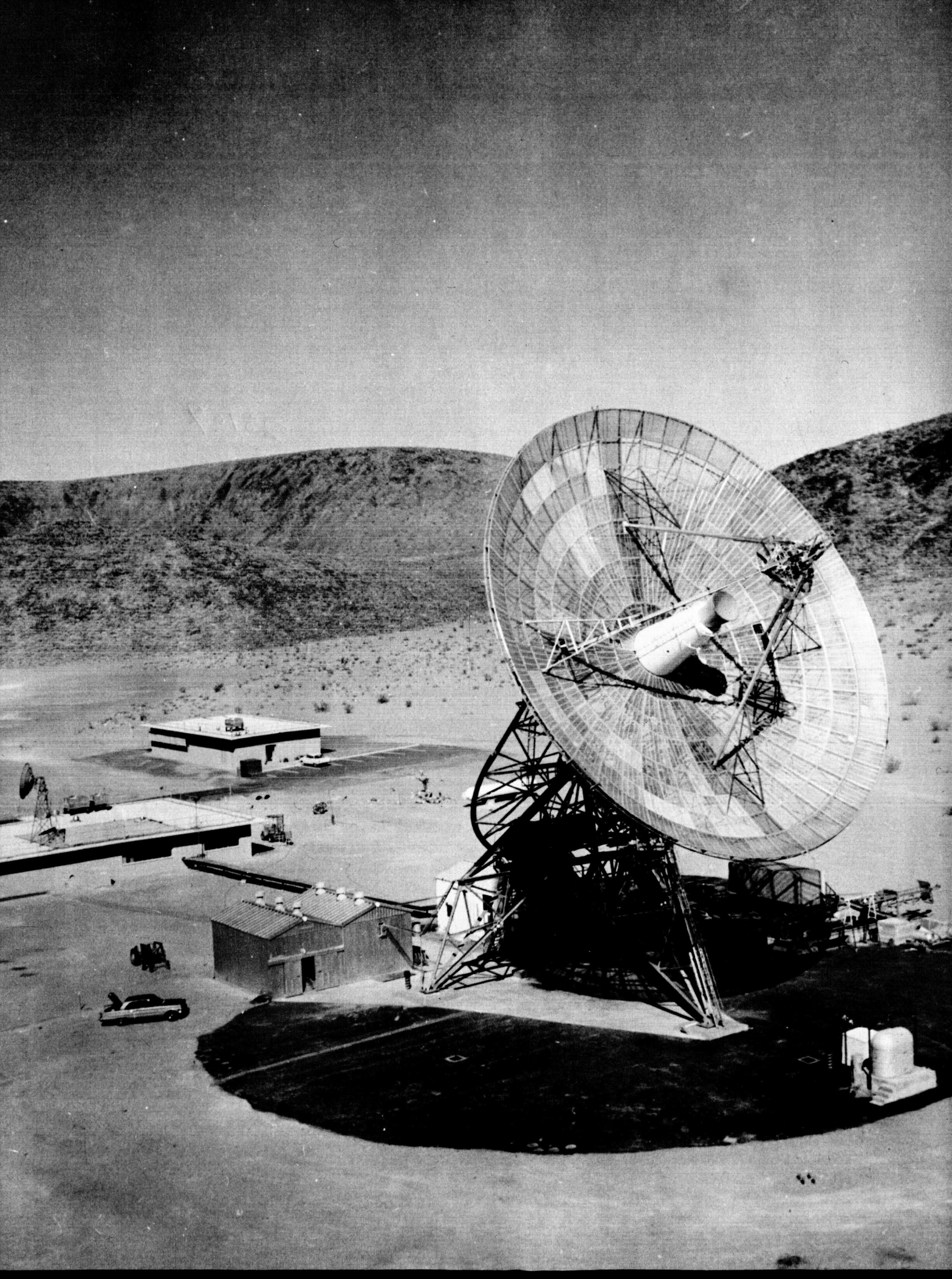
The descriptions of the five *Ranger* spacecraft, the flight plans, and the mission synopses are taken from published material on the *Ranger* project and are presented in this Memorandum to provide a better understanding of the network operations.

ABSTRACT

This document summarizes the technical activities of the Deep Space Instrumentation Facility in support of missions 1 through 5 of the *Ranger* project. The narrative includes a synopsis of each mission, a comprehensive account of the tracking operations, and a performance evaluation. The tracking and data acquisition support provided by the Atlantic Missile Range sites and the Space Flight Operations Center at the Jet Propulsion Laboratory are delineated also.



I. INTRODUCTION

The purpose of this Memorandum is:

a. To summarize the technical activities of the Deep Space Instrumentation Facility (DSIF) in support of missions 1 through 5 of the *Ranger* project.

b. To present in one document the important technical material associated with these activities.

c. To provide an historical account of the DSIF organization, equipment configurations, interstation communication networks, and tracking operations.

A limited description of spacecraft and launch vehicle flight performance is included as necessary to convey an understanding of the DSIF activities.

The National Aeronautics and Space Administration (NASA), through its Office of Space Sciences, established the *Ranger* Project at the Jet Propulsion Laboratory (JPL) of the California Institute of Technology in 1960. The project objectives were to develop the technology of spacecraft for lunar, planetary, and interplanetary exploration, to conduct a number of scientific experiments, and to gather data which could be useful in planning manned flights to the Moon and the planets.

Through its Office of Space Flight Operations, NASA established the Deep Space Net in 1958–9 and gave the Jet Propulsion Laboratory the responsibility for designing, developing, engineering, installing and operating the Net. In addition, JPL was to provide the supporting research and development necessary to maintain the Net at the state-of-the-art in space communications.

Figure 1 shows the organization comprising the Office of Space Flight Operations and the personnel involved in implementing the Deep Space Net during *Ranger* missions 1–5. Similarly, Fig. 2 shows an organizational breakdown of JPL during the *Ranger* missions, and Fig. 3 shows the DSIF organization for the missions.

Elliptical Earth orbits were planned for missions 1 and 2, and lunar impact trajectories were planned for missions 3–5. In each case, the launching was conducted at

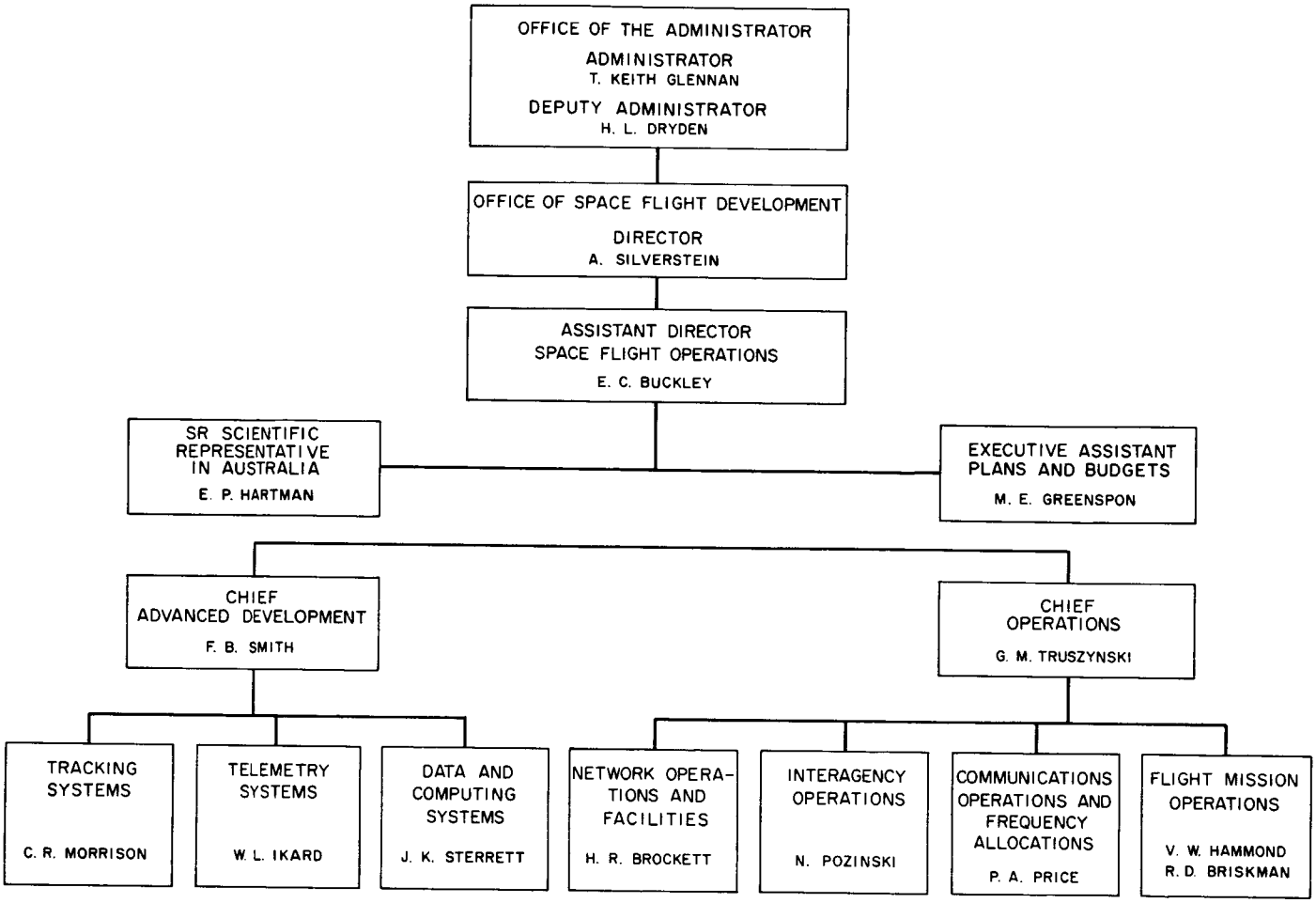


Fig. 1. NASA organization of Office of Space Flight Operations (1959 to November 1961)

Cape Canaveral (now Cape Kennedy) with the *Atlas–Agena B* as the launch vehicle. After liftoff, control of the flight was transferred from the NASA Launch Operations Center (now Kennedy Space Center) at the Cape to the Space Flight Operations Center (SFOC) at JPL in Pasadena.

In this Memorandum the five *Ranger* missions are presented in chronological order and include the following subject matter:

a. Flight Plan — the plan for conducting flight operations and the expected achievements.

b. Mission Synopsis — a recapitulation of significant events occurring throughout the mission.

c. DSIF Configuration — the equipment complement of each station, including the mission-oriented equipment.

d. DSIF Preparation for Mission — the station and net performance evaluation tests.

e. Tracking Operations — a chronology of DSIF operations during the mission.

f. Performance Evaluation — a discussion of accomplishments and remedial action taken on malfunctioning equipment.

g. Participation of Non-DSIF Agencies — the role of participants such as the Atlantic Missile Range (AMR) sites and the SFOC.

In addition, station organization charts and summaries of tracking operations (in the form of edited station logs) are included in the appendix at the rear of this Memorandum as supplementary information for each *Ranger* mission.

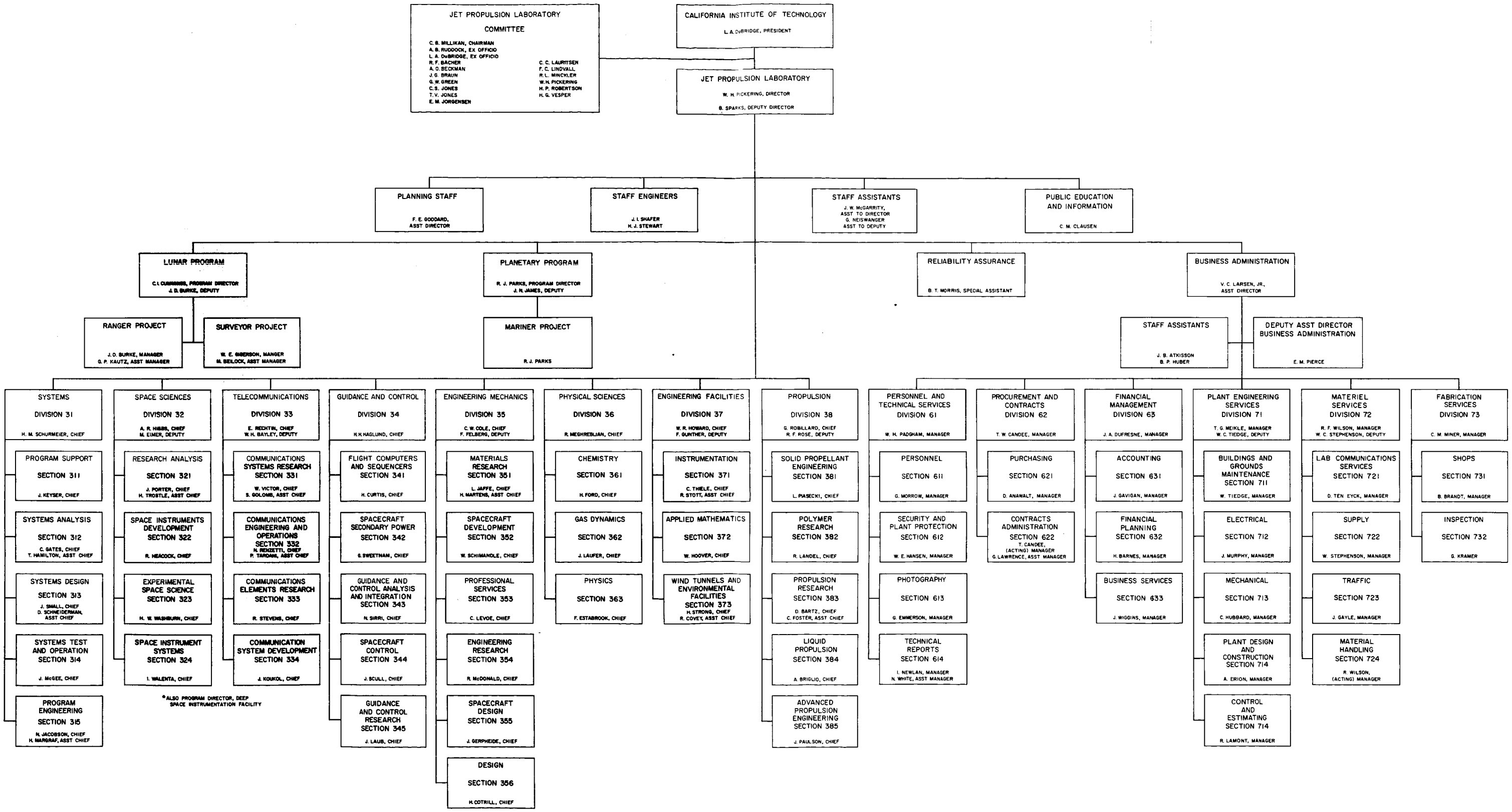


Fig. 2. JPL organization, July 1961

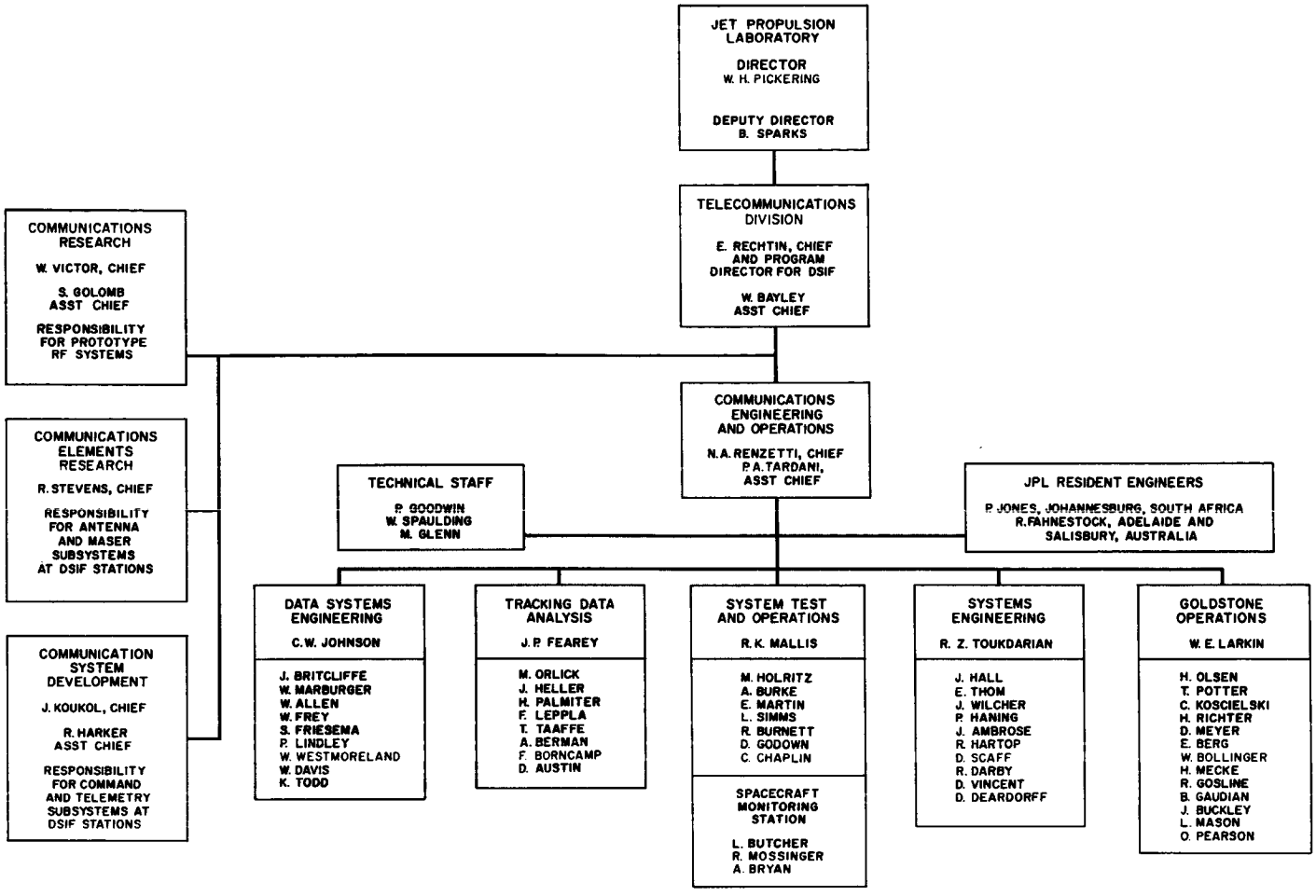


Fig. 3. DSIF organization for *Ranger* missions 1–5

At the time of *Ranger* missions 1–5, the DSIF consisted of four space communications stations located at three permanent installations approximately 120 deg apart in longitude around the Earth. In addition, two trailer-mounted (transportable) stations were used for the early (near-Earth) part of the trajectory.

The three permanent stations, which had 85-ft steerable paraboloidal antennas and associated electronics, were located at Goldstone, California (Pioneer and Echo Stations); Woomera, Australia; and Johannesburg, Republic of South Africa. A mobile Spacecraft Monitoring Station (SMS), used to obtain spacecraft radio transmitter frequency after liftoff and to record spacecraft telemetry during the early part of the flight, was located at Cape Canaveral. A Mobile Tracking Station (MTS), used to provide immediate post-injection tracking and telemetry reception and acquisition information for the larger stations, was located at Johannesburg.

During tracking operations, the DSIF stations were able to maintain continuous radio contact with the spacecraft once it was several thousand miles away from Earth. Because of overlap in coverage near the horizon, two stations were often in contact with the spacecraft at the same time, a condition that proved to be quite useful in transferring contact from one station to the next. The SFOC, through its Central Computing Facility, provided angle and frequency acquisition information for each of the DSIF stations in time for their respective tracking periods.

The DSIF operating schedules for support of the *Ranger* missions were planned to provide complete, 24-hr-per-day coverage during the critical parts of the mission (launch, midcourse maneuver, terminal maneuver, etc.) and 10-hr-per-day coverage during the cruise part. However, during the five missions each station actually tracked the spacecraft for the full duration of its own view period.

In its initial configuration for the *Ranger* missions, the DSIF was to provide:

a. Tracking Data – two angles, either hour angle (HA) and declination (Dec) or azimuth (Az) and elevation (El), and one-way or two-way doppler.

b. Commands – transmission to spacecraft of commands required for midcourse and terminal maneuvers, changes in telemetry mode transmission back to Earth, switching of spacecraft antennas, and other functions.

c. Telemetry data – scientific and engineering telemetry reception, scientific capsule data recording, and transmission of data to JPL in Pasadena.

Station capabilities of the DSIF are listed in Table 1; antenna and receiver parameters are listed in Tables 2 and 3, respectively.

In *Ranger* missions 1–5, the DSIF accomplished all tracking and data acquisition objectives and experienced no failures of consequence. In addition, the DSIF performed well during several highly nonstandard flight conditions, recovering sufficient data to make spacecraft performance analysis possible. Tracking data from the *Ranger* flights, particularly from *Ranger 4*, demonstrated the potential accuracy of the DSIF unified L-band system and the feasibility of precise radio guidance to the Moon and planets—later proved by the *Mariner II* flight to Venus and the *Ranger 6* flight to the Sea of Tranquillity on the Moon.

Table 1. DSIF station capabilities

Station	Receive	Transmit	Command	Two-way doppler
MTS	X	X		X
Pioneer	X	X[a]	X[a]	X[b]
Echo	X	X	X	X
Woomera	X	X[c]		
Johannesburg	X	X[d]	X[d]	X[d]

[a]A 25-w transmitter available for command capability only during *Ranger* missions 1 and 2.

[b]Precision pseudo-two-way doppler only (0.35 m/sec accuracy).

[c]A 50-w transmitter for two-way doppler during *Ranger 5*.

[d]Two-way doppler and command transmitter capability for *Ranger* missions 4 and 5.

NOTE: In addition to the above capabilities, all stations had angle tracking and readout, one-way doppler measurement and readout, and received signal strength measurement capabilities.

The *Ranger* flights also demonstrated the value of continuous telecommunications between a distant spacecraft and a network of Earth stations in (1) gathering engineering and scientific data, (2) conserving spacecraft weight by minimizing on-board data and energy storage, and (3) shortening the response time of ground control to flight events.

The *Ranger* flights also proved the soundness of an internationally managed network in which each country provided the local station management and staff under the overall technical direction of JPL/NASA. This approach produced excellent station performance, superior station morale, and minimum operating cost. The two overseas agencies cooperating in this project were the Weapons Research Establishment of the Department of Supply of the Commonwealth of Australia and the National Institute of Telecommunications Research of the Council for Scientific and Industrial Research of the Republic of South Africa.

The principal lessons learned by the DSIF from *Ranger* missions 1–5, lessons which led to modification of the original design and operation of the DSIF, were:

a. Engineering telemetry should be relayed from overseas stations to the new Space Flight Operations Facility (SFOF) in Pasadena in near-real time.

b. Preflight checkouts should be increased in number and scope.

c. Acquisition of spacecraft transmissions on the first orbit should be aided by special antennas and preflight predictions as well as by predictions made during the course of the flight; later acquisitions are easily accomplished from orbit determination calculations based on early tracking data.

d. Semiautomatic station performance monitoring should be increased to permit rapid validation of raw tracking and communication data and prompt correction of any nonstandard station performance; more station condition information should be sent to DSIF Control in Pasadena; signal strength data should be sent more automatically and accurately to DSIF Control.

e. Complete analysis of station performance depends upon a knowledge of spacecraft attitude control and telecommunications performance; hence, performance monitoring is required both at the station and in the SFOF in Pasadena, and close liaison

Table 2. DSIF antenna parameters

Station	Antenna type	Reflector size, ft	Tracking rate, deg/sec		Antenna gain, db		Antenna ellipticity, db		Excess noise temp, °K
			Elevation or hour angle	Azimuth or declination	Receiving	Transmitting	Receiving	Transmitting	
Goldstone	Az-El[a]	85	2.0	2.0	44.5[b] ±0.6	41.7[c] ±0.8	1.4±0.1	3.0±0.1	43[d] $^{+0}_{-15}$
Goldstone	HA-Dec[e]	85	0.7	0.7	45.5[f] ±0.6	41.7[c] ±0.8	<1.0[g]	3.0±0.1	43[d] $^{+0}_{-15}$
Goldstone	HA-Dec	85	0.7	0.7	45.5[f] ±0.5	—	<1.0[g]	—	15 ±5
Woomera	HA-Dec	85	0.7	0.7	44.5[b] ±0.6	—	1.4±0.1	—	43[d] $^{+0}_{-15}$
Johannesburg	HA-Dec	85	0.7	0.7	44.5[b] ±0.6	41.7[c] ±0.8	1.4±0.1	3.0±0.1	43[d] $^{+0}_{-15}$
MTS	Az-El	10	10.0	10.0	22.8[h] ±0.5	23.3[i] ±0.5	0.6±0.2	2.7±0.5	100[d] ±50

[a] *Ranger* missions 1–4 only.

[b] Gain for matched polarization includes bridge loss.

[c] Sum channel of tracking antenna used for transmitter feed. Gain shown is for matched polarization right-hand circular. Does not include ellipticity but includes bridge loss.

[d] Antenna temperature is for 960-Mc tracking feed except for Goldstone Cassegrain. Sky temperature of 0°K is assumed.

[e] *Ranger 5* mission only.

[f] Circularly polarized Cassegrain listening feed. Gain figures are estimated and are for matched polarization.

[g] Estimated.

[h] Gain includes sum channel bridge loss and is for linear isotropic source. Tolerance includes possible variations due to ellipticity and measurement errors. Matched polarization will increase gain figure by 3 db.

[i] Sum channel of tracking antenna used for transmitter feed. Gain includes sum channel bridge loss and is for linear isotropic source.

Table 3. DSIF receiver parameters

Item	Goldstone Az-El	Goldstone HA-Dec	Woomera	Johannesburg	MTS
Nominal frequency, Mc[a]	960.05 ±0.03	960.05 ±0.03	960.05 ±0.03	960.05 ±0.03	960.05 ±0.03
Receiver noise figure, db, $F = Te/T + 1$	1.8[b] ±0.2	0.5[b] ±0.2	1.8[b] ±0.2	1.8[b] ±0.2	6.3[c] ±0.5
Receiver transmission line loss, db	0.3[d] ±0.2	0.1 ±0.05	0.3 ±0.2	0.3 ±0.2	0.80[d] ±0.2
Receiver diplexer, db	0.4 ±0.2			0.4[e] ±0.2	
Loop noise bandwidth at threshold, cps	20 ± 4 (60 ±10)	20 ± 4 (60 ±10)	20 ± 4 (60 ±10)	20 ± 4 (60 ±10)	20 ± 4 (60 ±10)
Threshold, dbm, 20 cps $28W_{L_0}$	−162 ±1.5	−162 ±1.5	−162 ±1.5	−162 ±1.5	−155 ±1.5
Maximum input signal level, dbm	−65	−65	−65	−65	−45
Residual phase modulation crystal oscillator phase jitter contribution	less than 3 deg[f] pp	less than 3 deg[f] pp	less than 3 deg[f] pp	less than 3 deg[f] pp	less than 3 deg[f] pp

[a] 960.05 Mc is basic two-way received frequency. 960.15 Mc and 960.25 Mc are one-way capsule listening frequencies.

[b] 220 ± 30°K is the estimated system noise temperature for the parametric receiver system. 75 ± 10°K is the measured system noise temperature for the maser system.

[c] Measured at 30 Mc. The MTS figure was measured with noise injected at the diplexer.

[d] Consists of 0.30 db from hybrid bridge to diplexer; 0.3 db for diplexer; 0.1 db from diplexer to front end. 0.1 db is included for mismatch losses.

[e] Estimated figure for *Ranger 4* and *5* missions only.

[f] For input signal level of −60 dbm with 150-cps noise bandwidth.

between DSIF, SFOF, and flight project analysts is mandatory.

f. It is impossible to guarantee failure-free operation of a network, but it is practical to design a spacecraft telecommunications network in which anticipated failures (communication outages due to ionospheric anomalies, ground equipment fatigue, etc.) are inconsequential.

g. Future missions will require that more accurate and earlier tracking and telemetry data be received closer to spacecraft injection into deep space orbits; the present configuration is adequate for *Ranger*, *Mariner*, *Surveyor* Block I, *Pioneer*, and probably *Lunar Orbiter*.

Although the *Ranger* missions individually fell short of expectations, the five missions as a group were successful in furthering spacecraft technology and in crystallizing deep space communication and tracking techniques. Indeed, without the lessons learned from the early *Ranger* flights, the *Mariner II* mission to Venus in 1962 could not have been the success it was.

II. *RANGER 1* MISSION

A. *Flight Plan*

Ranger 1 (Fig. 4) was a deep space flight intended to test the basic features of a spacecraft whose relatively simple design and operation were to pave the way for the more sophisticated spacecraft needed for future missions to the Moon and planets. As such, the mission had the following overall objectives:

a. To test basic elements of the spacecraft and the DSIF.

b. To evaluate performance and gain operating experience with the *Atlas–Agena B* launch vehicle and associated systems.

c. To test scientific measurement equipment and to measure phenomena of interest along the selected trajectory.

In relation to succeeding missions, the *Ranger 1* mission was limited by the following simplifications:

a. No midcourse maneuver system.

b. No landing capsule.

c. Fixed geocentric injection conditions and only moderate firing-time constraints.

The primary objective of the flight was to conduct environmental and life tests on the spacecraft components and to test the in-flight performance of the attitude control system, solar and battery power supplies, communications equipment, and telemetry.

The secondary objective of the flight was to measure characteristics of the solar-related phenomena (Table 4), thereby increasing the total knowledge of the Sun–Earth

Table 4. *Ranger 1* scientific experiments

Experiment	Description
Solar corpuscular radiation analysis	Electrostatic analyzers for study of low-energy charged particles, most of which originate in the Sun.
Medium-energy range particle detection	Three sets of particle detectors: 1. Cadmium sulfide cells. 2. Geiger-Mueller counter. 3. Gold-silicon solid state detector.
Cosmic ray ionization rate measurement	Quartz-fiber integrating type ionization chamber to measure bombardment rate of energy charged particles.
Triple-coincidence cosmic ray analysis	Proportional-counter tubes to measure kinetic energy of fast charged particles in space.
Magnetic field analysis	Rubidium vapor type magnetometer to measure direction and strength of interplanetary magnetic field.
Solar X-ray detection	Scintillation counters to detect low-energy sunbursts of X-rays.
Observation of neutral hydrogen geocorona	Parabolic mirror with ionization chamber to depict nature and distribution of hydrogen cloud around the Earth.
Cosmic dust detection	Scintillator-type photomultiplier and microphone to measure particle impact rate, energy, momentum, and direction.

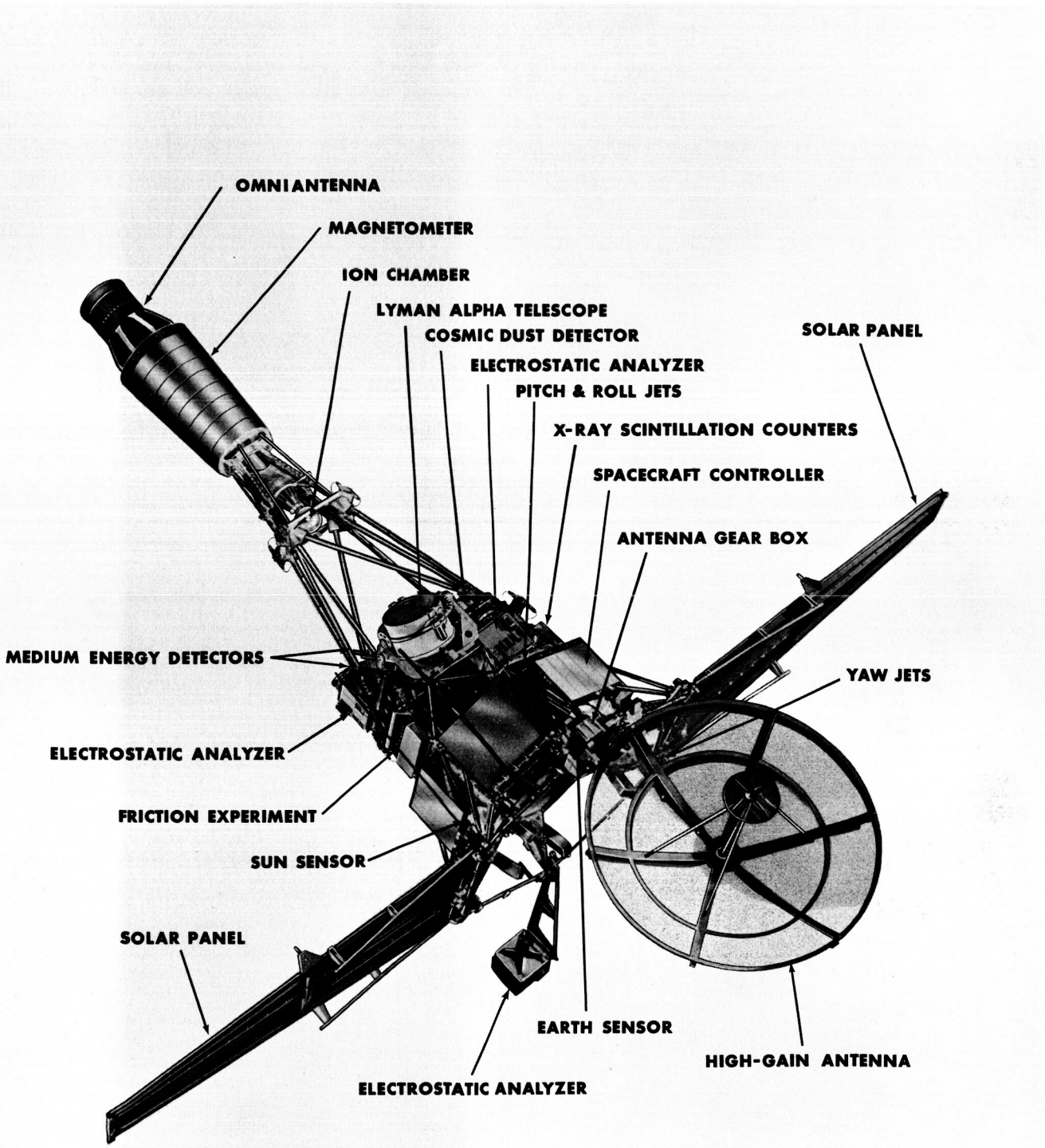


Fig. 4. *Ranger 1* spacecraft

relationship and furthering the development of scientific equipment needed in the future. These scientific experiments were an integral part of the planned program but were carried on a noninterference-with-engineering-measurements basis.

After the first *Agena* burning period, the spacecraft and *Agena* were to be injected into a parking orbit. The spacecraft was to be injected into its transfer trajectory by the second *Agena* burn. Following injection, the solar panels were to be erected, the attitude-control system was to be activated, and the solar power system was to be put into operation.

Following this, the spacecraft was to turn about its roll axis. Upon Earth acquisition by optical sensors the spacecraft was to continue to coast with its roll axis pointed toward the Sun, and its high-gain antenna pointed toward the Earth to maintain communications. Provisions were made so that certain scientific equipment could be kept pointed toward the Earth.

B. Mission Synopsis

Ranger 1 was launched from Cape Canaveral at 100410.26Z on 23 August 1961 and completed 110 orbits, each of approximately 90 min duration. The spacecraft reentered the Earth's atmosphere at approximately 0900Z during its 111th orbit on 30 August.

Due to a malfunction of the *Agena B* stage, *Ranger 1* was injected into a near-Earth orbit (apogee 312.5 mi, perigee 105.3 mi) instead of the highly elliptical geocentric orbit (apogee 788,500 mi, perigee 4,067 mi) for which it was programmed (Fig. 5).

C. DSIF Configuration

1. Station Equipment

An equipment configuration for each station in the DSIF is shown in Fig. 6–10. The numbers appearing in the individual blocks within these figures are keyed to

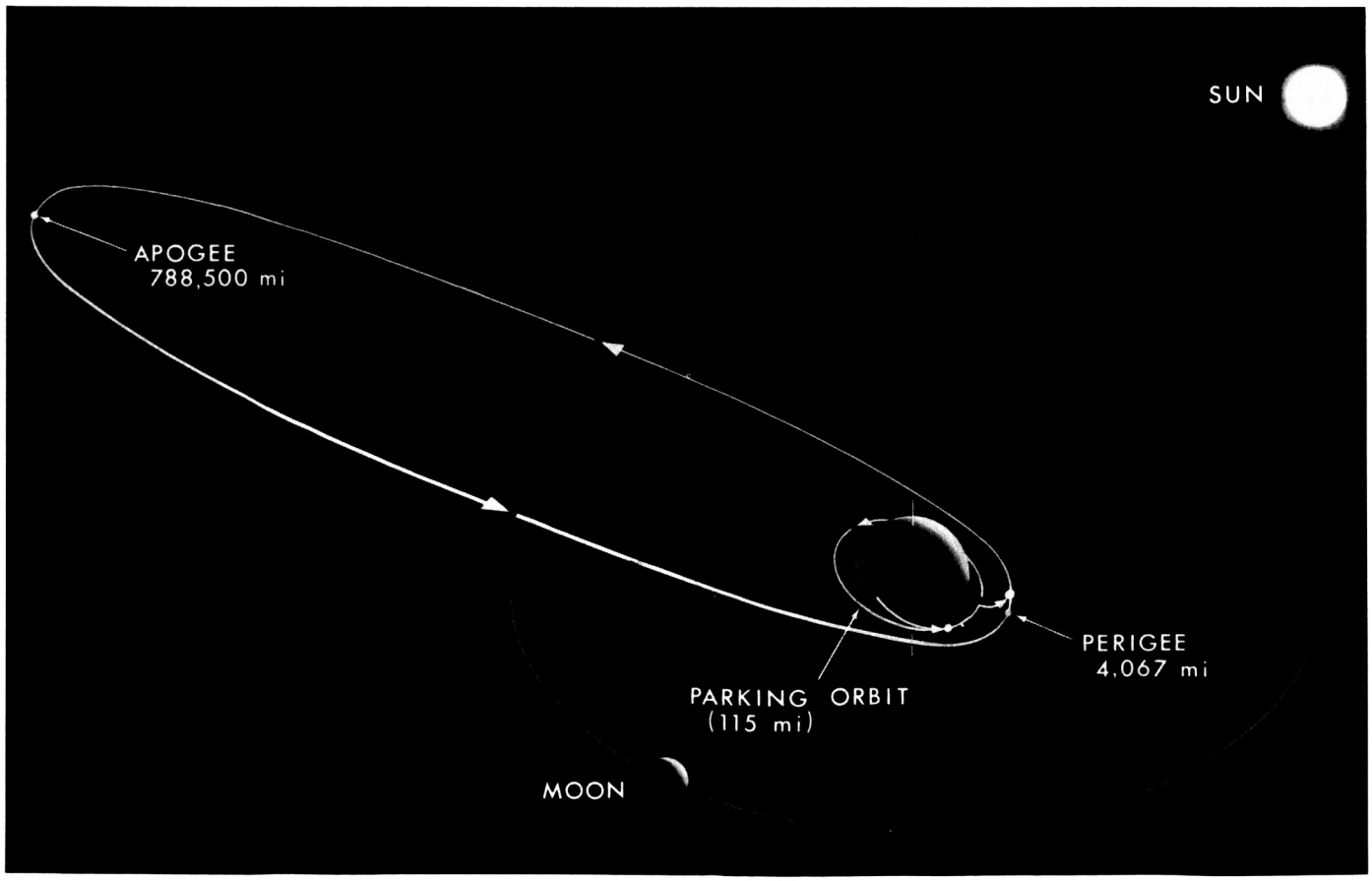


Fig. 5. Programmed trajectory of *Ranger 1*

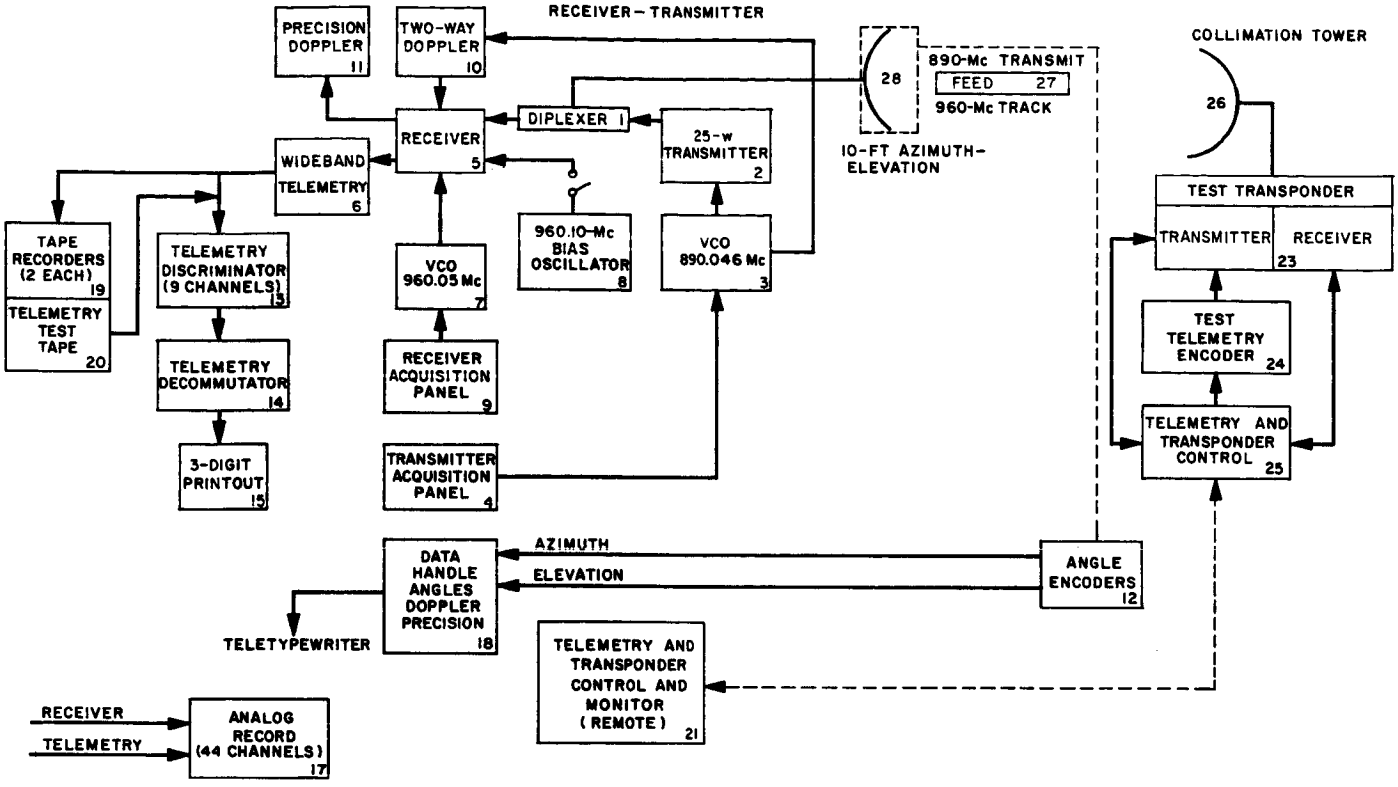


Fig. 6. Mobile Tracking Station equipment configuration for *Ranger 1*

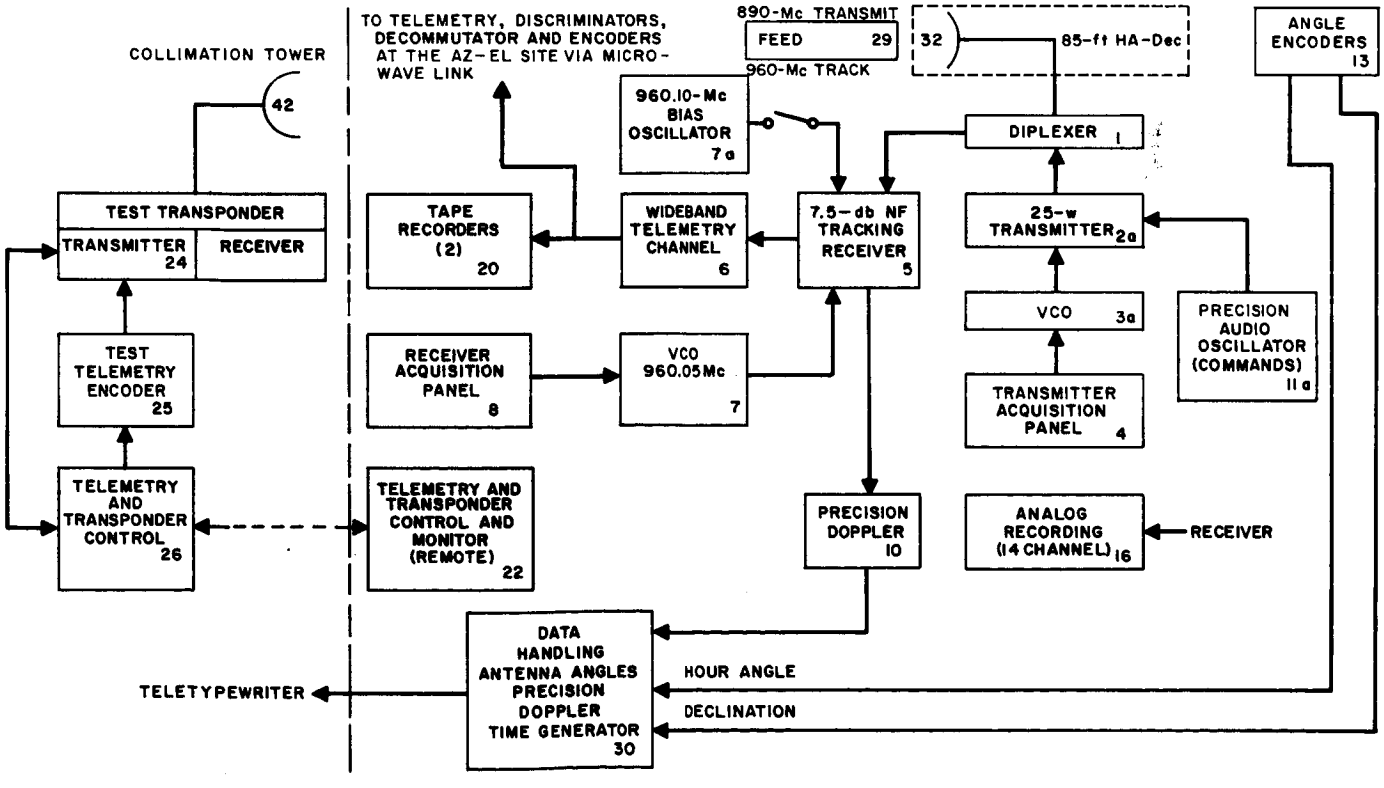


Fig. 7. Goldstone Pioneer Station equipment configuration for *Ranger 1*

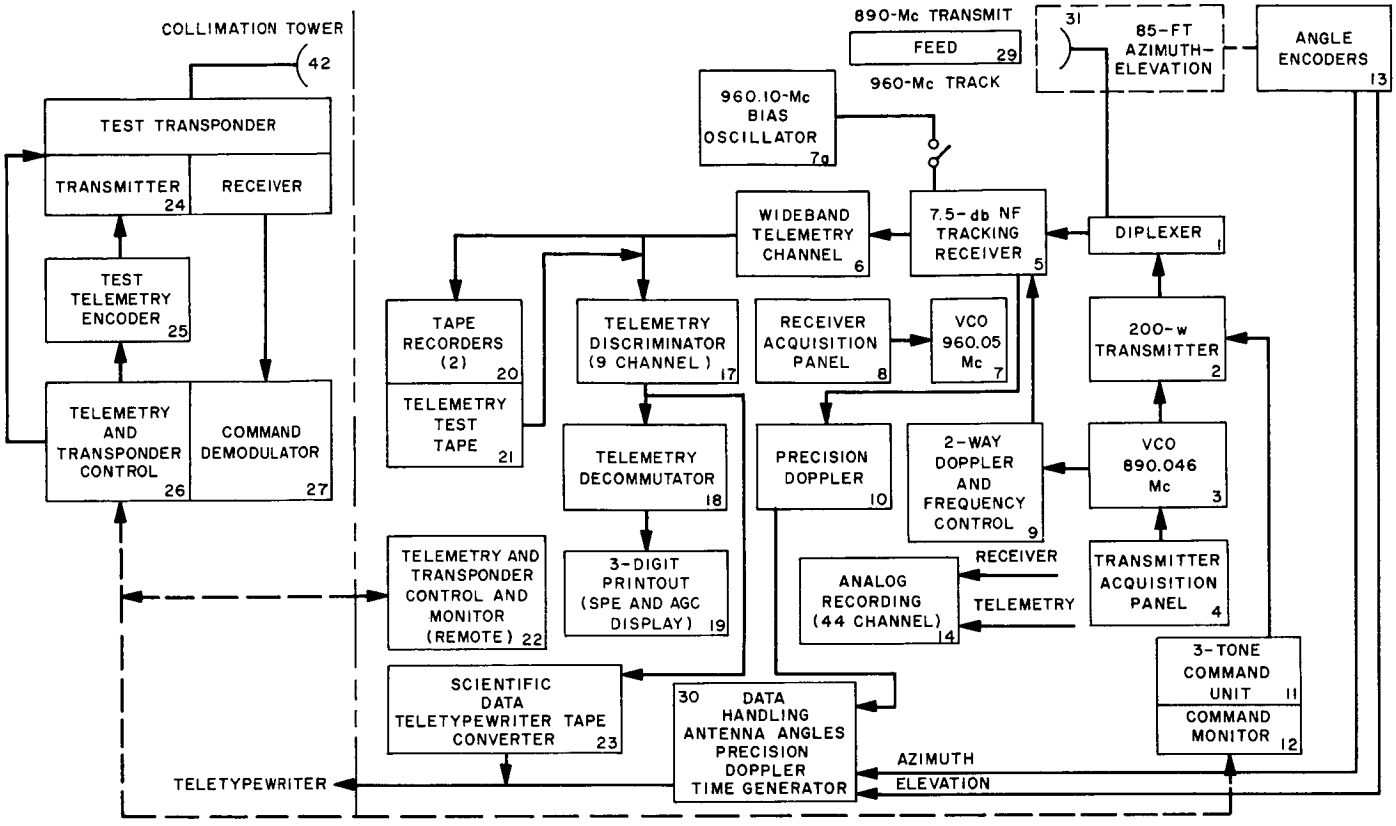


Fig. 8. Goldstone Echo Station equipment configuration for *Ranger 1*

the equipment descriptions given in Table 5 for the MTS and Table 6 for the stations having 85-ft antennas.

In addition to the standard equipment complement at the DSIF stations, the following special equipment was installed for the *Ranger 1* mission:

Scientific data teletype converter. A scientific data teletype converter was installed at each station primarily to translate the scientific data output of the phase-lock discriminator channels into a format suitable for teletype transmission. The data could, therefore, be fed directly into a teletype transmitter and sent to the Central Computing Facility in near real-time.

Engineering telemetry digital decommutator. Engineering telemetry digital decommutators were installed in the Johannesburg (Fig. 11), Goldstone, and Mobile Tracking stations. Two types of telemetry decommutators were used by the DSIF stations: the MTS used a model 2000 and the Goldstone and Johannesburg stations used model 2001P. Basically they used the same logic but were mechanized in a different manner. The greatest difference appeared in the printout: model 2000 provided a three-digit commutator address and model 2001P provided a two-digit address. Outputs from the decommutators were used to provide a visual display of the commutated subcarrier frequencies, a high-speed tabular printout, and a digital tape storage. The digital data output consisted of a time readout, a commutator address, a three-digit subcarrier frequency, and a telemetry system data condition.

Precision doppler system. A precision doppler measuring system was installed in the Goldstone Station and the MTS. The two-way precision doppler, using the ground transmitter as a reference frequency, could achieve nearly 0.157-m/sec radial velocity accuracy (when based on a short-term stability of DSIF secondary frequency standard).

Command coder. A command coder system was installed at the Goldstone Station to transmit commands to the spacecraft in the event of certain nonstandard spacecraft operation. Three commands could be transmitted by the ground system: (1) RTC-1 – roll override command; (2) RTC-2 – hinge override command; and (3) RTC-3 – antenna switchover command.

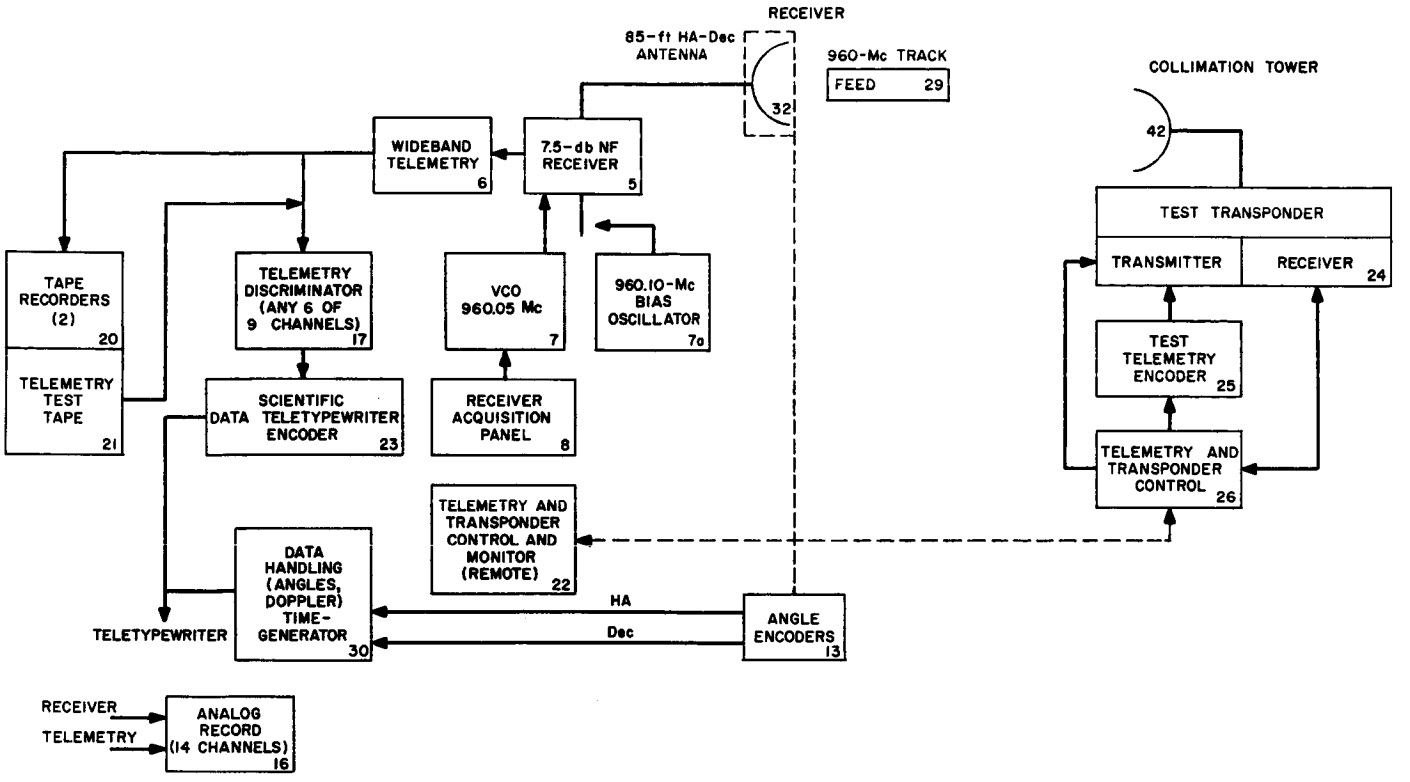


Fig. 9. Woomera Station equipment configuration for *Ranger 1*

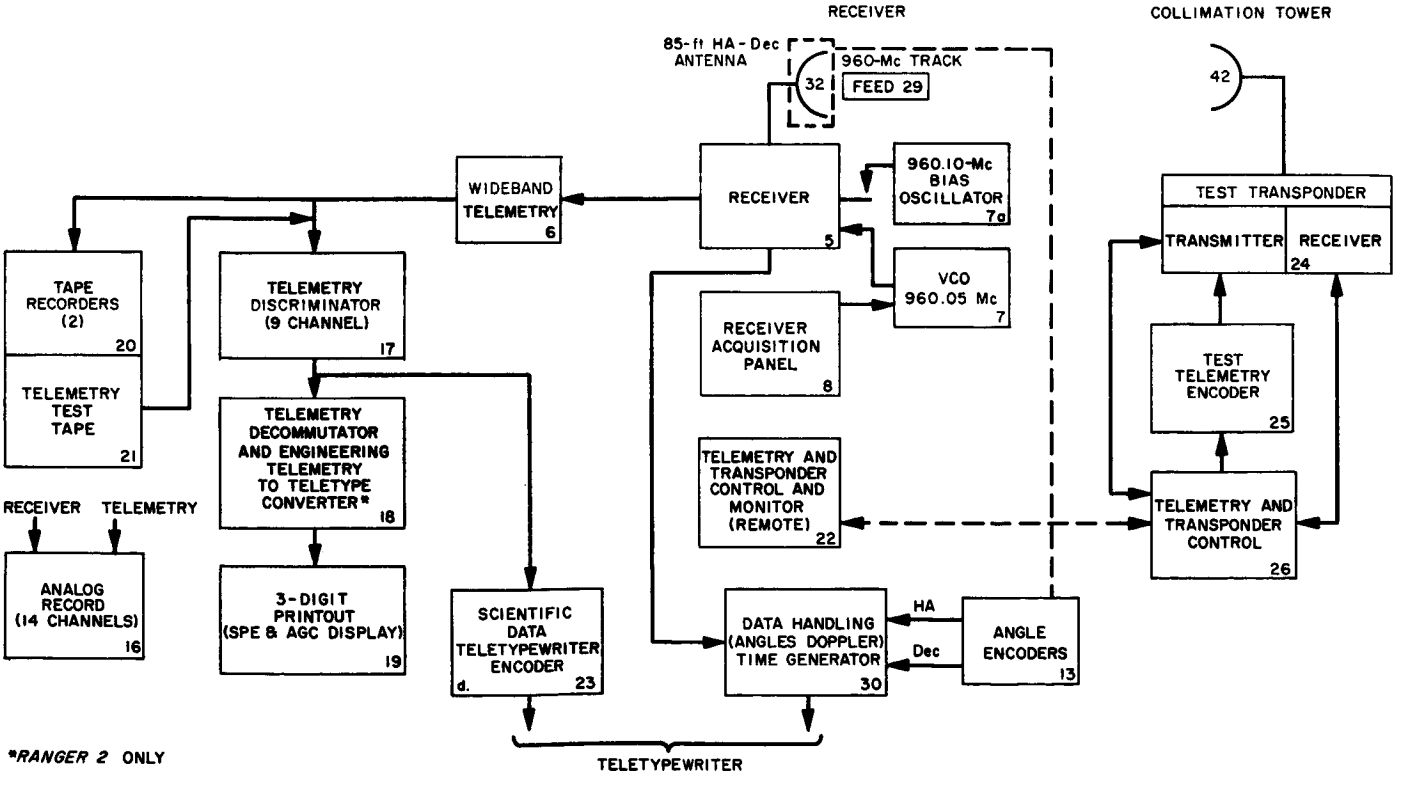


Fig. 10. Johannesburg Station equipment configuration for *Ranger 1*

Table 5. DSIF equipment for Mobile Tracking Station

Fig. 3 Block reference number	Description
1	Diplexer, reference channel: 960 Mc listen; 890 Mc transmit; 25-w capability
2	25-w transmitter, 890 Mc, includes multiplier chains and phase modulator
3	Voltage tuned oscillator—890.046 Mc
4	Transmitter acquisition panel
5	Tracking receiver
6	Wideband telemetry detection channel
7	Voltage tuned oscillator 960.05 Mc
8	Bias oscillator 960.10 Mc
9	Receiver acquisition panel
10	Two-way doppler capability used for increased accuracy of measurement
11	Precision doppler monitoring equipment
12	Antenna angle encoders
13	Telemetry discriminators for local recording and display of telemetry
14	Telemetry decommutator for spacecraft engineering data
15	Three-digit printout for decommutated telemetry.
17	Analog recorder, Sanborn Recorder (8 chan), Midwestern Recorder (36 chan)
18	Data handling system used to transmit angle tracking and doppler data to JPL
19	Magnetic tape recorder
20	Telemetry test tape used to test discriminator and decommutator system
21	Test transponder control and monitor at the MTS control trailer
23	Test transponder 890 and 960 Mc used for systems test of DSIF installation
24	Test telemetry encoder
25	Test transponder control and monitor at collimation tower site
26	Collimation antenna
27	960-Mc tracking feed
28	10-ft Az-El antenna

Table 6. DSIF equipment for 85-ft antenna stations

Fig. 7–10 Block reference number	Description
1	Diplexer reference channel—960 Mc listen, 890 Mc transmit, 200-w capability
2	10-kw transmitter used at 200 w, 890 Mc—includes multiplier chains and phase modulator
2a	25-w, 890-Mc transmitter including multiplier chain and phase modulator
3	Voltage tuned oscillator 890.046 Mc
3a	Voltage tuned oscillator
4	Transmitter acquisition panel
5	Goldstone Duplicate Standard (GSDS) tracking receiver
6	GSDS wideband telemetry detection channel (3.5–5 kc)
7	GSDS voltage tuned oscillator 960.05 Mc
7a	Bias oscillator for reception at 960.10 Mc
8	GSDS receiver acquisition panel
9	Two-way doppler capability used to increase measurement accuracy
10	Precision doppler monitoring equipment
11	Three-tone spacecraft command unit
11a	Precision audio oscillator used to generate command tones

Table 6. (Cont'd)

Fig. 7–10 Block reference number	Description
12	Command monitor located in control room of operations building
13	Antenna angle encoders
14	Analog recording—Sanborn Recorder (8 chan); Midwestern Recorder 603 (36 chan)
16	Analog recording—Midwestern Recorder (14 chan)
17	Telemetry discriminators for local recording and display of telemetry a. Channel selectors b. Loop filters
18	Telemetry decommutator for spacecraft engineering data
19	Three-digit printout for decommutated telemetry.
20	Magnetic tape recorder
21	Telemetry test tape used to test discriminator and/or decommutation system

Fig. 7–10 Block reference number	Description
22	Test telemetry and transponder remote control from operations building
23	Scientific data TTY encoder converts spacecraft scientific data for transmittal to JPL
24	Test transponder 890/960-Mc used for systems test of DSIF installations
25	Test telemetry encoder
26	Test telemetry and transponder control at collimation tower site
27	Three-tone command demodulator used for testing *Ranger 1* and 2 command capability
29	890/960-Mc tracking feed
30	Time generator and data handling system used to transmit angle tracking and doppler data to JPL
31	85-ft antenna Az-El
32	85-ft antenna HA-Dec
42	Collimation antenna

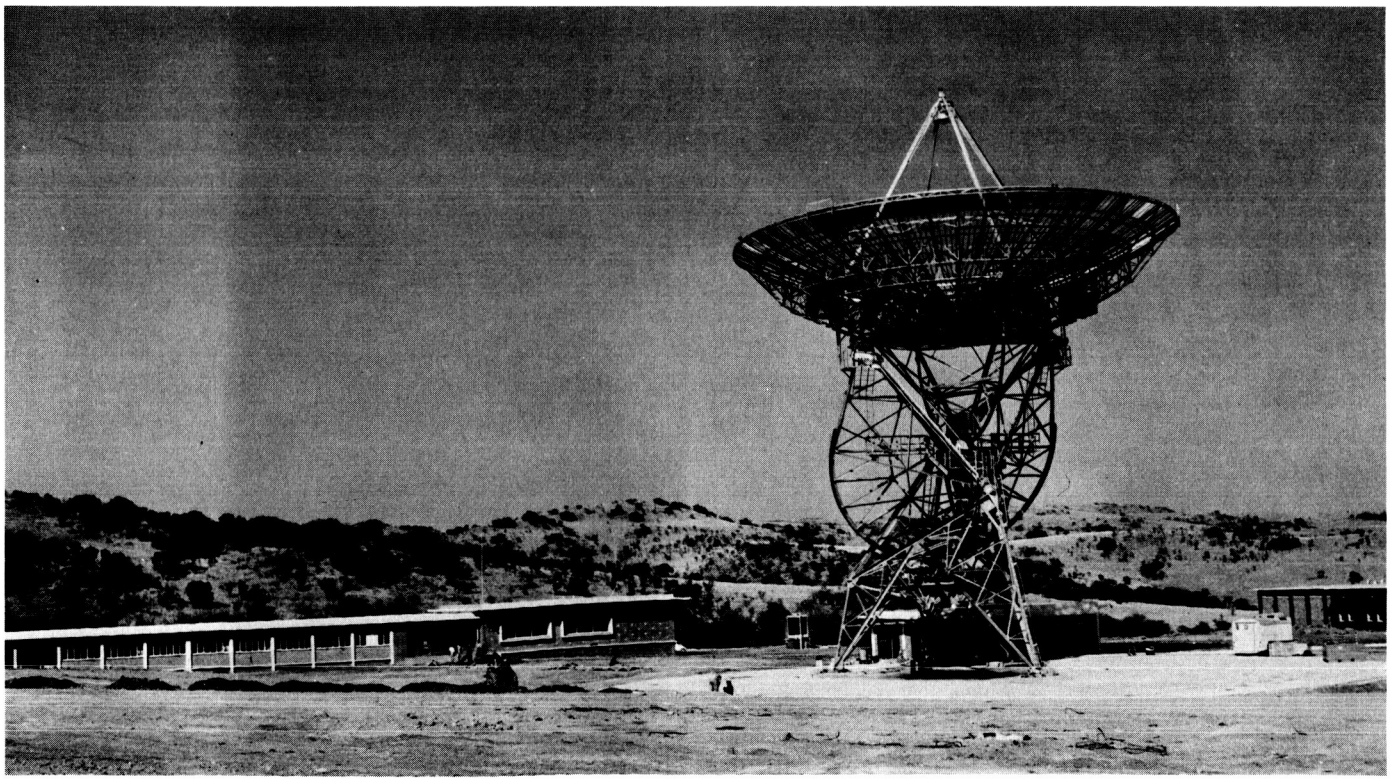


Fig. 11. Johannesburg Station

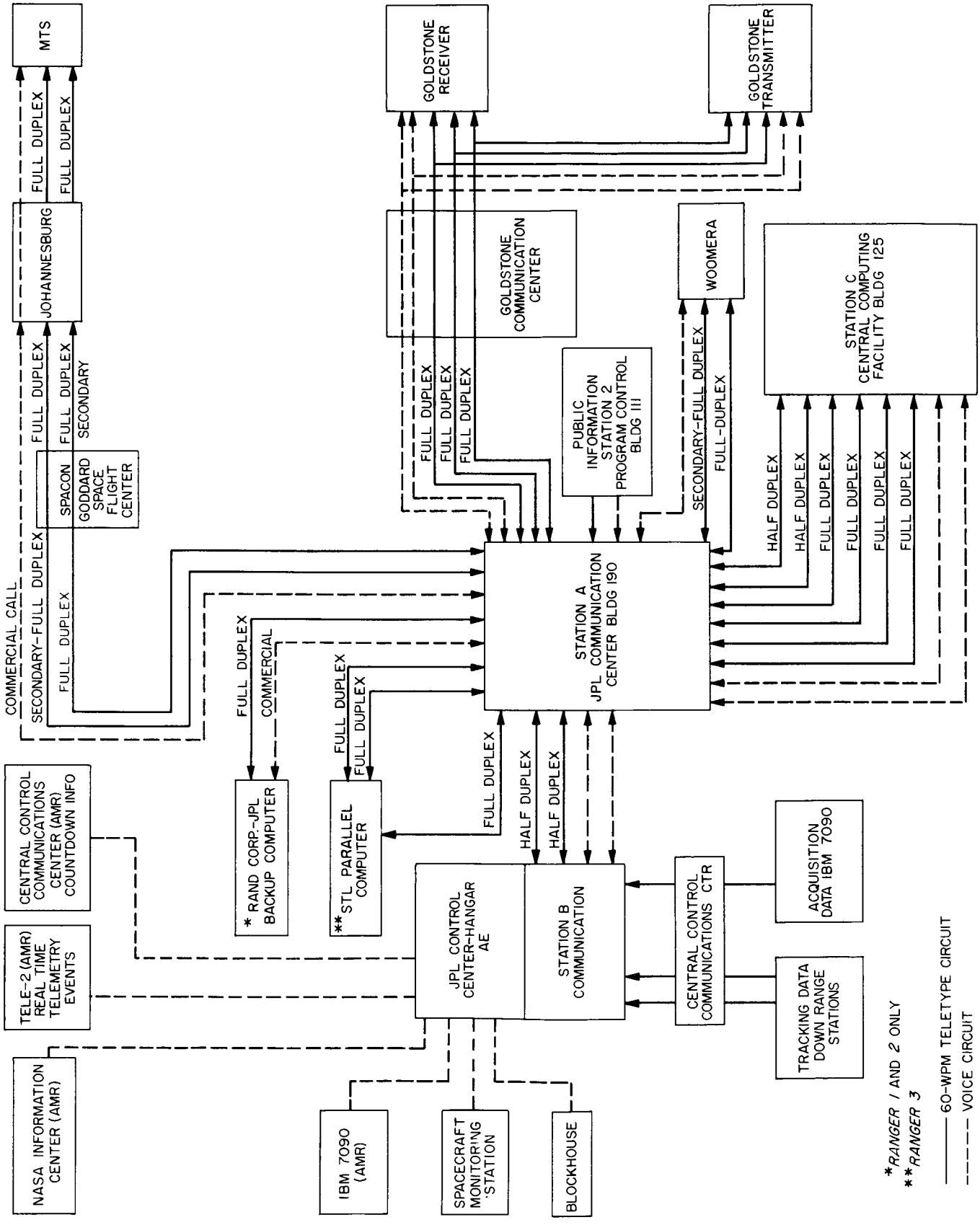


Fig. 12. Communications net for *Rangers 1, 2, and 3*

2. Interstation Communications Net

The communications net used during the *Ranger 1* mission is shown in Fig. 12. The teletype lines, the primary communications links for the mission, were used to transmit data from the DSIF stations to cognizant personnel and to pass acquisition, prediction, and administrative information to the DSIF stations. Voice circuits were available for high priority real-time communications when the teletype circuits were found impractical.

All these communications links were monitored and routed through the Net Control and JPL Communications Center. The JPL Communications Center was able, because of its proximity to the Tracking Director's Office, to function as the DSIF Net Control. All messages pertaining to the mission passed through or were originated by Net Control.

D. DSIF Preparation for Mission

Preparation of the DSIF for the *Ranger 1* mission began in mid-June of 1961. Equipment checkout (Fig. 13 and 14), performance evaluation tests, and net integration tests were conducted to determine local equipment and personnel readiness.

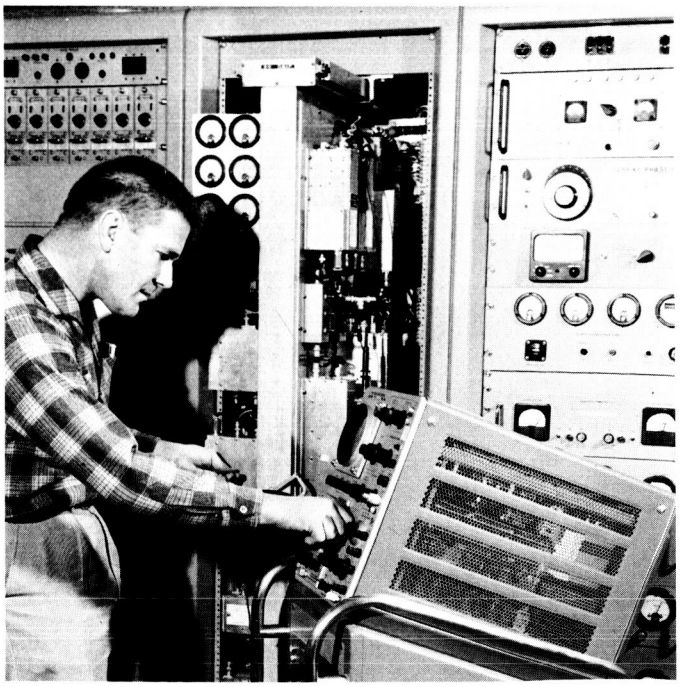


Fig. 13. Checkout of receiver modules at Goldstone Echo Station

1. Performance Evaluation Tests

The following tests were conducted:

Multiple star tracks. Tests consisted of short tracks of at least 20 stars at different declination angles.

Star meridian crossings. Tests consisted of star tracks across the meridian of at least 20 stars.

Single star tracks. Separate stars, well spread in declination, were individually tracked from horizon to horizon.

RF boresight shift vs. polarization angle. Tests consisted of recording data samples for each 10 deg of polarization angle at two signal levels, −130 and −140 dbm, with the antenna servo system in the low-speed tracking mode.

Aircraft tracking tests. Tests were conducted using aircraft to obtain low-speed data runs.

Telemetry threshold tests. Tests were conducted using the test transponder and telemetry data encoder to determine the dynamic threshold of the telemetry discriminators.

Telemetry acquisition tests. Tests were performed to give the operators experience in acquiring the telemetry signals and synchronizing the associated telemetry equipment.

RF acquisition tests. Tests were performed with aircraft flying simulated trajectories to familiarize operators with one-way and two-way RF acquisitions.

Telemetry data tests. Tests were conducted in order to familiarize the operators with the data marking procedures necessary for engineering telemetry data transmission.

Dummy runs. Tests were designed primarily to train station personnel in techniques and procedures necessary to fulfill the prelaunch and postlaunch obligations of each station.

2. Net Integration Tests

Several dummy runs for the *Ranger 1* mission were conducted by the Space Flight Operations Center (Fig. 15) from mid-June through late July to familiarize personnel with their respective duties during an actual mission, and to optimize overall procedures.

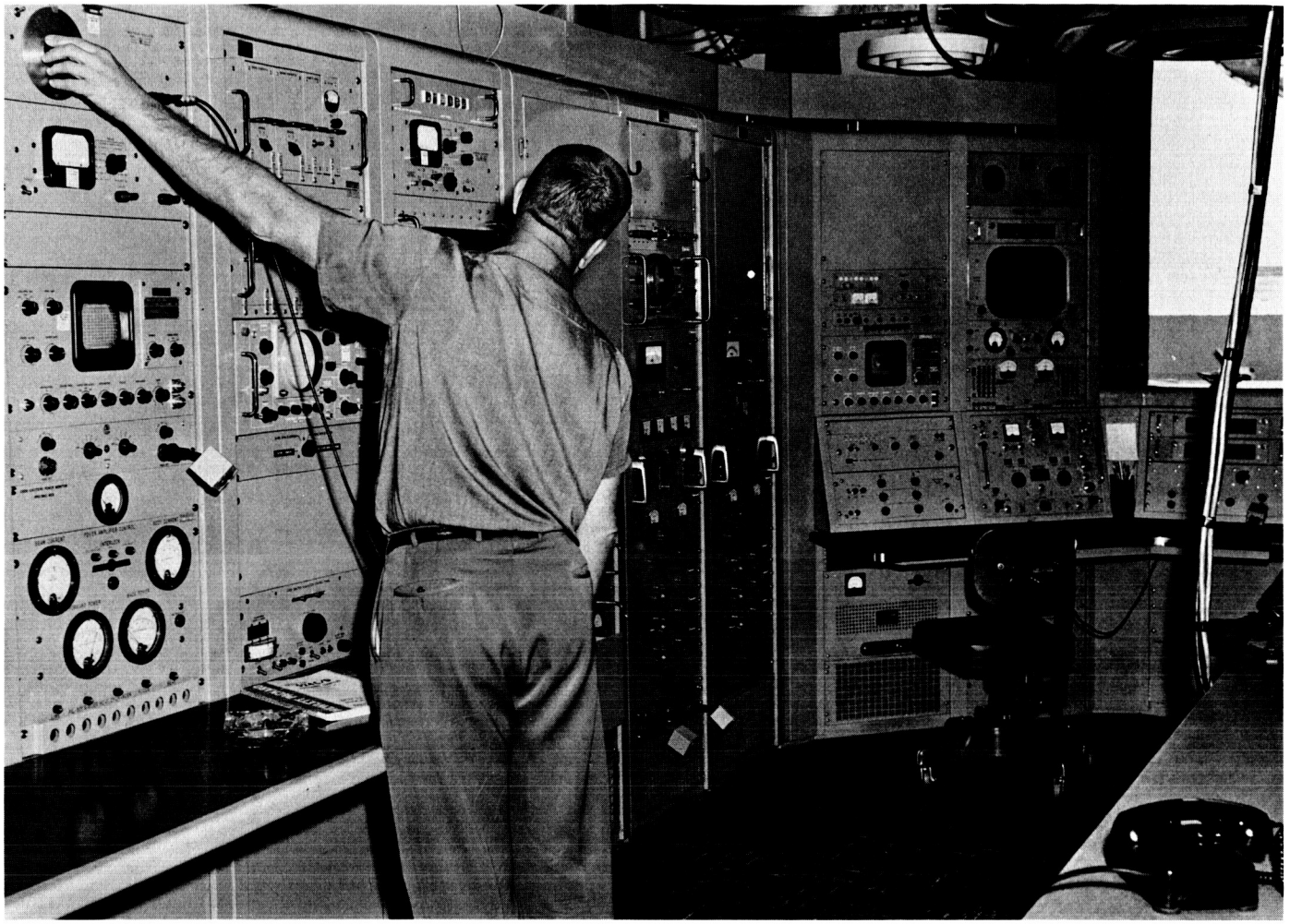


Fig. 14. Checkout of transmitter at Goldstone Echo Station

Since the actual data are difficult to simulate at the stations during these tests, tracking, scientific and engineering data tapes were prepared at JPL and mailed to each station for use during the tests. The tracking and scientific data teletype tapes were transmitted by the stations at the proper times during the sequence of events. Tracking data transmission simulated actual recording and transmission practice by transmitting data according to the data sample schedule. The engineering data digital tape was read and a teletype tape cut and transmitted at the proper time during the sequence of events by each station. A number of copies of the engineering digital data tapes were mailed to the stations and a new one used for each dummy run. In order to time the operation and develop optimum procedures for the handling of engineering data, station personnel involved in this operation simulated actual conditions of reading the tape, cutting the engineering data teletype tape, and transmitting the data.

Two types of tests were conducted. One type exercised the data flow system and the Central Computing Facility and also tested the reliability of the communications net. For this type of test, the DSIF stations passed information at the required times. The second type of test was more realistic and involved not only the full capability of the Central Computing Facility and communications net but also as much of the DSIF station equipment and personnel as possible.

E. Tracking Operations

Since the *Ranger 1* orbit was nonstandard, the primary tracking load was borne, as previously planned for such an occurrence, by the Goldstone Echo Station and the MTS. The Woomera and Johannesburg stations were secured during the first day, as soon as it became apparent that the spacecraft was in a near-Earth orbit. The

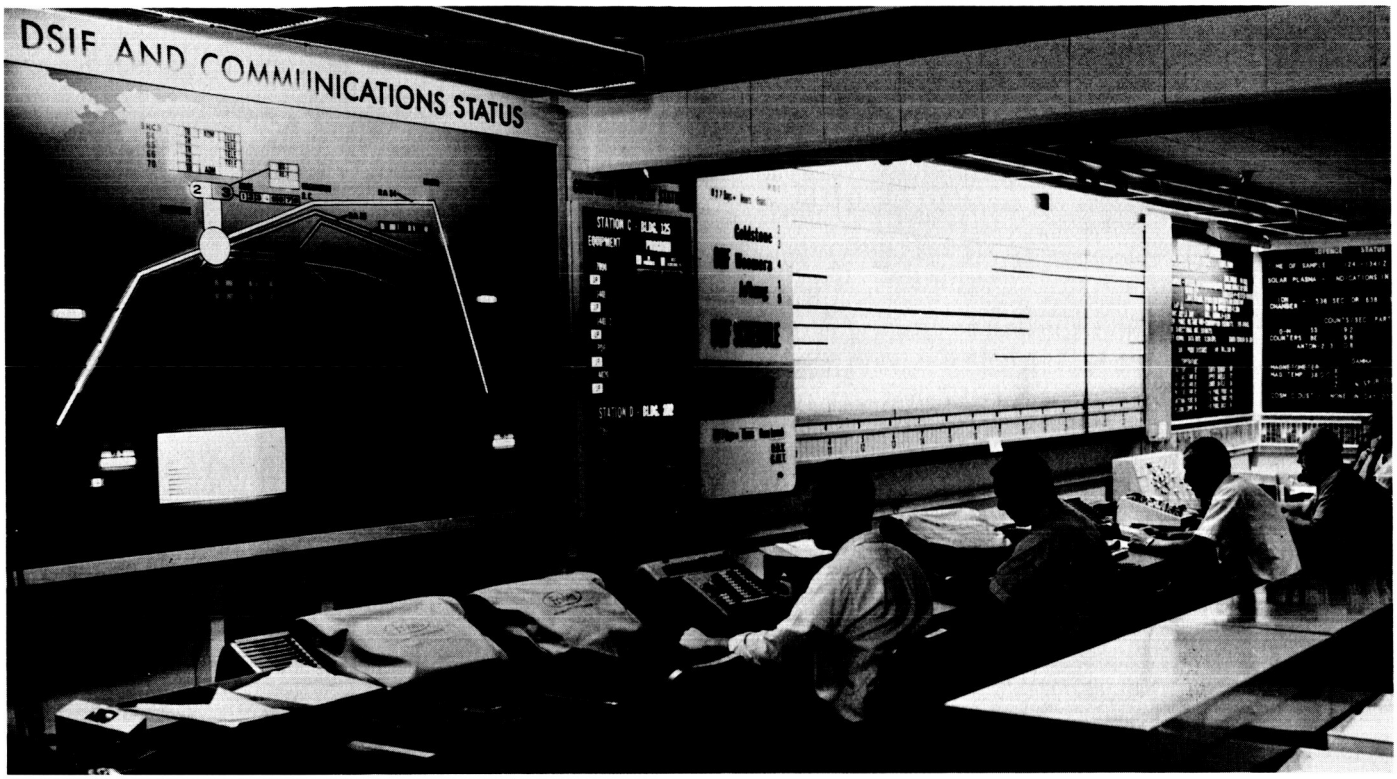


Fig. 15. Space Flight Operations Center at JPL

majority of the passes at these stations were either in an area where the antenna could not track or where they crossed at angular rates that exceeded the capabilities of the antenna drive.

The Az-El mounted antennas at Goldstone and the MTS had the rate capabilities necessary to obtain tracking data for orbit determination. After the orbit had been determined, the stations at Johannesburg and Woomera were put back in operation and obtained valuable information on many orbits.

Attempts to track were made on 60 orbits, most of which were successful, meaning that either some position or telemetered information or both were obtained. Considering the high angular rates of the low orbit the DSIF did better than expected. Woomera tracked *Ranger 1* on 25 August at 01501Z, and at 092311Z Johannesburg acquired the spacecraft. On 24 August, in an exercise, the Johannesburg Station, using MTS prediction data, tracked the spacecraft and obtained ten good telemetry points which were transmitted to JPL.

The injection failure of the launch vehicle made tracking and communications difficult. The short time (approximately 6 to 10 min) that the spacecraft was visible to each station limited the amount of tracking and telemetry data which could be obtained, and also limited the time during which commands could be sent from Goldstone. Despite these difficulties, telemetry was received, but because of the limited recording time, was never completed. Telemetry retrieval was further hampered by the depletion, after Orbit 61, of the batteries used to power the transponder.

After Orbit 61, the only reliable signal was the beacon signal which carried only low rate telemetry information. Occasionally, however, a transponder signal would be detected by a station spectrum analyzer, probably as a result of the transponder batteries being periodically recharged by the solar panels.

On Orbit 91, 29 August, Woomera attempted the first track of the day with negative results. A search was made by all stations the rest of the day, but neither the transponder nor the beacon frequencies were heard. It was concluded that the beacon power supply had failed and the DSIF was secured.

During the mission, the Goldstone stations transmitted six commands (Table 7) to the spacecraft. This transmission was performed to demonstrate the command

Table 7. *Ranger 1* command transmissions

Transmitting station	Command	Orbit	GMT
Pioneer	Hinge override	46	071504
Pioneer	Hinge override	47	084715
Echo	Antenna switchover	30	071258
Echo	Antenna switchover	31	084800
Echo	Antenna switchover	31	085056
Echo	Roll override	49	115740

capability of both Echo, the primary station, and Pioneer, the backup station. Verification of reception and performance was received for all commands sent by Echo, but no indications of success were received by Pioneer. The effects of commands sent by Echo were easier to detect, since they produced a change in signal level. The command for an antenna hinge angle change, transmitted by Pioneer, did not produce a signal level change due to the proximity of the spacecraft to the Earth.

Although it had not been planned to use the SMS (Fig. 16) to track beyond the launch phase, a minimum crew maintained a continuing effort from launch through the early hours of 27 August. Additionally, one command was sent to the spacecraft by the SMS, successfully effecting antenna changeover from omni- to high-gain.

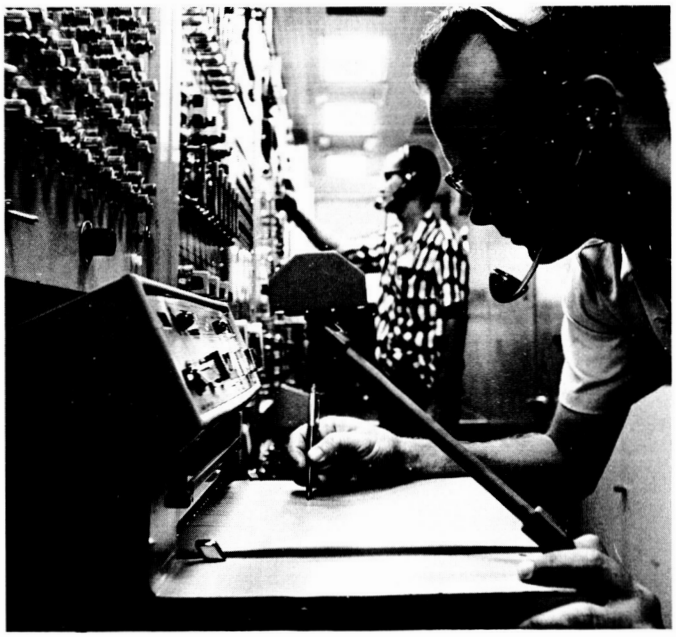


Fig. 16. Spacecraft Monitoring Station at Cape Canaveral

Two temporary modifications were made to the Woomera, Johannesburg, and Goldstone Pioneer stations to increase their tracking capabilities:

1. The servo hydraulic system was replumbed to take out the antibacklash feature, thereby increasing the tracking rate capability from 1 deg/sec to 1.5 deg/sec, with reduced tracking accuracy.
2. The receiver reference channel was connected to the 6-ft calibration dish that was mounted on the side of the main antenna. Although this modification reduced the system gain by 20 db, it increased the telemetry reception beam width to 10 deg but left the tracking beam width at approximately 1 deg.

F. Performance Evaluation

The *Ranger 1* mission, while obviously not a complete success, did accomplish many objectives. Successful operation of the spacecraft was indicated from the signal strength observations and telemetry information provided by the DSIF. The operations involved in tracking the spacecraft provided the DSIF Net Control Center with experience in organizing and maintaining communications with stations located one-third of the way around the world from the JPL Control Center. Personnel received experience in operating the various systems and in performing the various operational and administrative details involved in a tracking mission. A large amount of experience was also gained in the acquisition of a low fast-moving spacecraft. During a normal operation, this important event occurs only on the first day at the station located near the spacecraft injection point.

G. Participation of Non-DSIF Agencies

1. Space Flight Operations Center

The SFOC responded to the highly nonstandard *Ranger 1* mission very satisfactorily. After initial acquisition by the DSIF, and establishing the fact that the spacecraft was in a nonstandard Earth satellite orbit, the DSIF attempted to track the spacecraft on each visible pass. The Central Computing Facility of the SFOC was able to reduce all usable near-real time telemetry data obtained from the DSIF. The magnetic tapes of the

telemetry recorded at the DSIF stations were returned to the Data Reduction Laboratory at JPL for reduction.

2. Atlantic Missile Range

The AMR was assigned the responsibility of providing JPL with:

1. Orbital elements of the parking and transfer orbits.
2. Acquisition angles for the Johannesburg and Mobile Tracking stations.
3. Raw data for the backup role by JPL.

It is believed that the delay in supplying the parking orbit was caused by the necessity of having to first supply look angles to Ascension Island. The loss of the use of the "Twin Falls Victory" (TFV) tracking ship with its FPS-16 and high data rate (10 pt/sec) resulted in the attempt to form an orbit with too little Antigua data. The computing facility at AMR lost the use of the majority of good Antigua data during this computation time. The lost data were subsequently retransmitted and a good orbit resulted.

The transfer orbit, using Ascension data, was delayed by:

1. Difficulty in rejecting bad data, which was caused by "beacon-stealing" by an AMR station.
2. Poor radio data transmission conditions.
3. Lack of available telemetry defining the time of second *Agena* burn.

When the data were edited and an assumed nominal time of second *Agena* burnout chosen, a good orbit resulted.

The raw data from AMR reached JPL with very few transmission errors. Although the Antigua data had no transmission errors, they were not used by JPL because of an input error in the 7090. The Ascension data, however, were used by JPL in real time to compute the initial orbit.

III. *RANGER* 2 MISSION

A. Flight Plan

Ranger 2 had the same flight plan as *Ranger 1*, and had the same flight objectives, which were:

a. To conduct environmental and life tests on the spacecraft components.

b. To test the inflight performance of the attitude control system, solar and battery power supplies, communications equipment, and telemetry.

c. To conduct scientific experiments (Table 4).

B. Mission Synopsis

Ranger 2 was launched from Cape Canaveral at 081221.5Z on 18 November 1961 on an *Atlas–Agena B* vehicle. After a nominal *Atlas* boost phase, the *Agena B* ignited for the first burning period and placed the *Ranger-Agena* vehicle in a near nominal parking orbit having a period of 88.31 min, with apogee 147.2 mi and perigee 97.5 mi. The *Agena* second burn did not occur, and the spacecraft remained in the parking orbit without obtaining the highly eccentric Earth orbit for which it was programmed. The spacecraft gyro measurements obtained from AMR telemetry records indicated that the *Agena* was rolling at an excessive rate during this period.

Confirmation of mechanical separation of spacecraft and *Agena* was obtained from *Agena* telemetering on the second pass over the AMR. Electrical separation was verified by the fact that the programmed controller commands were executed.

After the fifth orbit, contact with the spacecraft could not be obtained by any of the DSIF stations. Reentry of *Ranger 2* was estimated at 0400Z on 19 November 1961.

C. DSIF Configuration

The DSIF equipment configuration for the *Ranger 2* mission was identical to the one used for the *Ranger 1* mission (Fig. 6–10) except for the addition of a teletype converter at Johannesburg. The Johannesburg Station took signals from the digital printer and provided a punched tape record of the engineering telemetry.

The communications net for the *Ranger 2* mission was also identical to the one used for the *Ranger* 1 mission (Fig. 12).

D. DSIF Preparation for Mission

Preparation for the *Ranger 2* mission began the first two weeks of October 1961 at all stations except the Goldstone Pioneer Station which, because of other commitments and its intended role as a backup for the Goldstone Echo Station, did not begin preparation until 15 October.

DSIF preparations consisted of:

1. Star tracks for evaluating antenna optical pointing accuracy.

2. Dynamic tracking tests using an airborne RF beacon for evaluating the RF tracking characteristics of the antennas.

All stations participated in the net integration test on 18 October. Station operations during the test were satisfactory and the DSIF was considered ready and operational for the *Ranger 2* mission. After unsuccessful launch attempts on 20, 23, and 25 October, the *Ranger 2* mission was rescheduled for 18 November.

Although the DSIF was operational for all *Ranger 2* events, a few difficulties were encountered. One problem was that, while communications with the DSIF stations were generally good, some outages occurred on the Johannesburg circuits due to poor propagation conditions over the North Atlantic. The Goldstone Echo Station suffered a failure of the azimuth data encoder unit, and a spare encoder unit was installed. The Woomera Station (Fig. 17) had a number of component failures

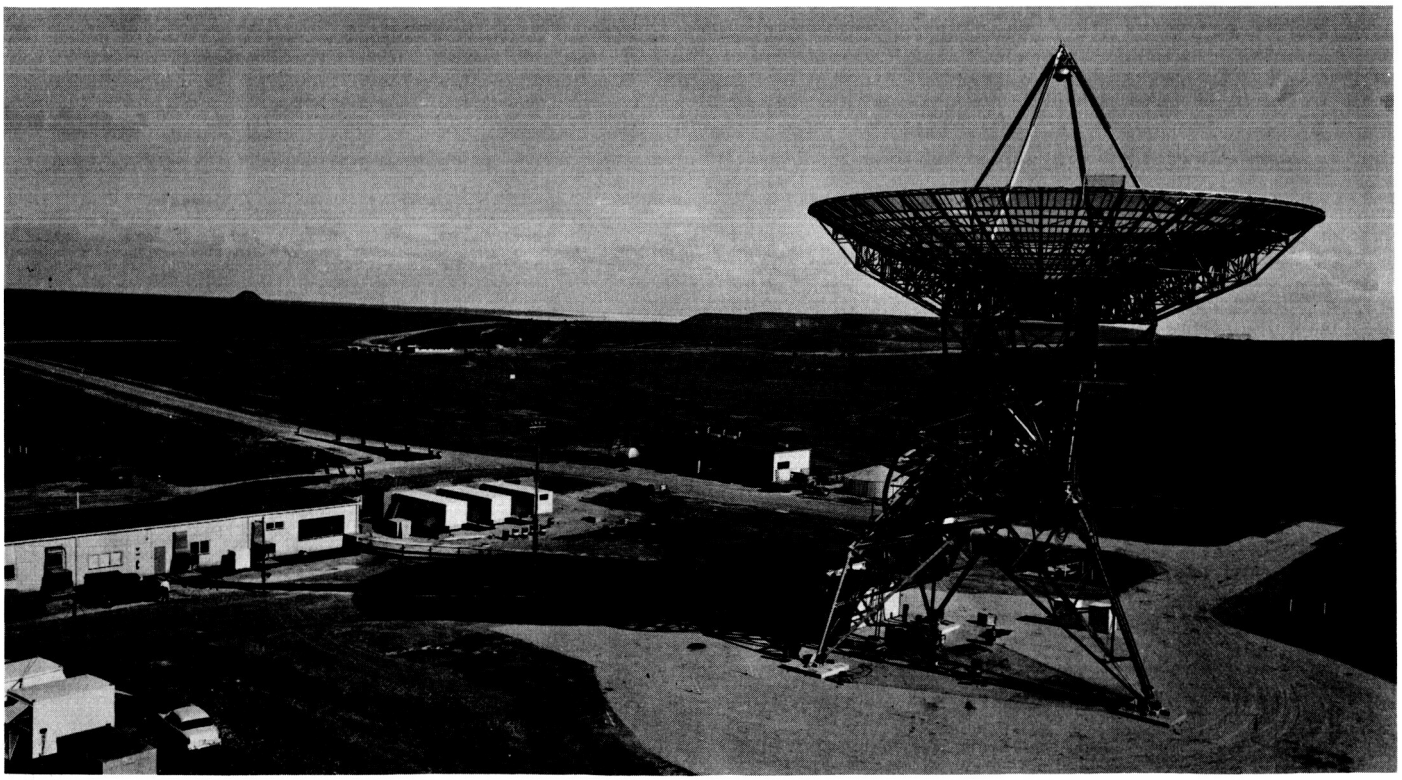


Fig. 17. Woomera Station

in the data handling system. These problems were resolved in teletype conferences between operating personnel at Woomera and engineers at JPL.

While the spacecraft was held in readiness (Fig. 18) for the 18 November launch attempt, the DSIF maintained its own operational readiness by conducting routine maintenance and subsystem tests (Fig. 19 and 20). The Goldstone Pioneer Station repeated the star tracks and dynamic tracking tests conducted prior to the first three launch attempts. An operational readiness test on 16 November confirmed that the DSIF was ready for the next *Ranger 2* launch attempt.

E. Tracking Operations

The DSIF was ready and operational for the 18 November launch of *Ranger 2*. Teletype and voice circuits between JPL Net Control and the DSIF were established at 0637Z. These circuits were operational until 0805Z when one South African teletype circuit failed because of propagation difficulties and was never restored.

Acquisition data for the DSIF were transmitted to JPL by the AMR sites prior to acquisition by the MTS. The spacecraft was due over the MTS horizon at 0840Z. At 0841Z, the MTS began using the pointing data as a guide for antenna positioning. The spacecraft transponder signal was acquired at 084438Z and tracked in a one-way mode until 084830Z when the transponder was acquired in a two-way lock. Because of the elevation angles and angular tracking rates required, it was apparent that the *Agena* second burn had not occurred, and that the spacecraft had remained in its nominal parking orbit.

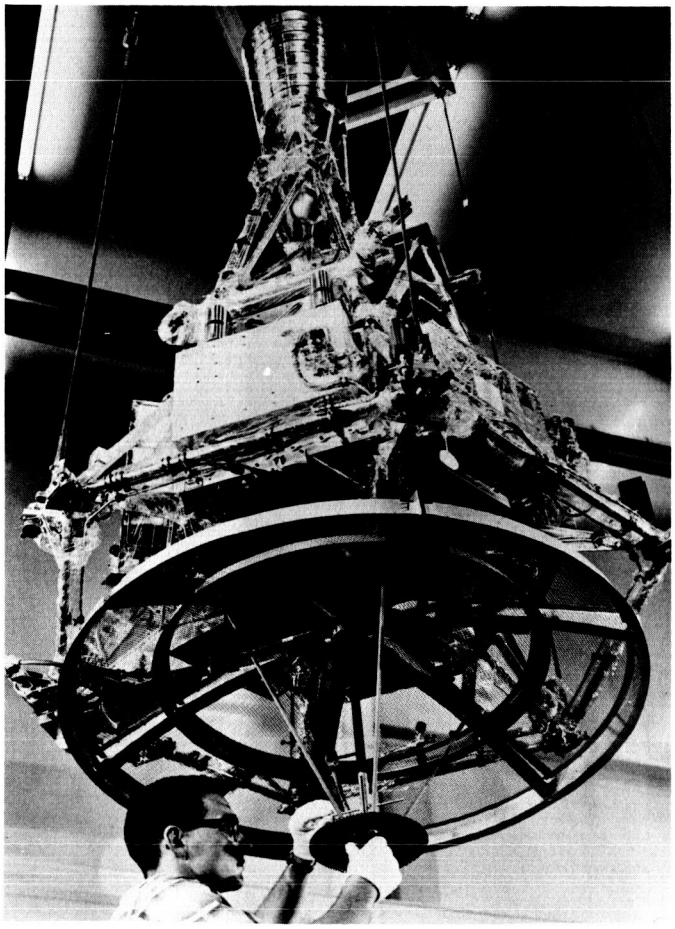


Fig. 18. Final adjustments being made to *Ranger 2* high-gain directional antenna

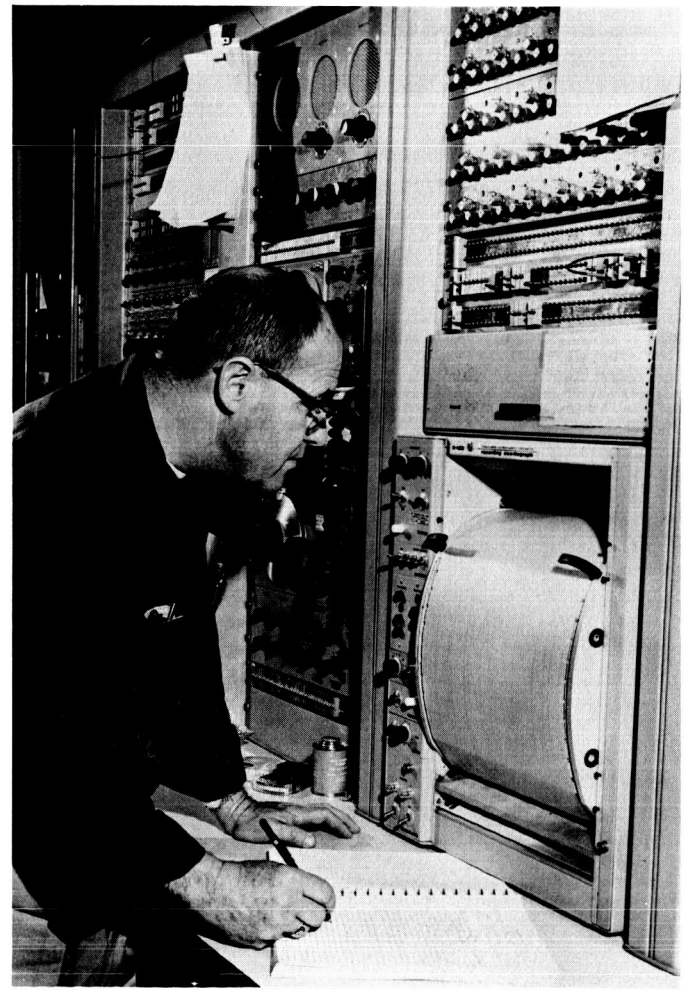


Fig. 19. Performance check of Goldstone Echo Station instrumentation system

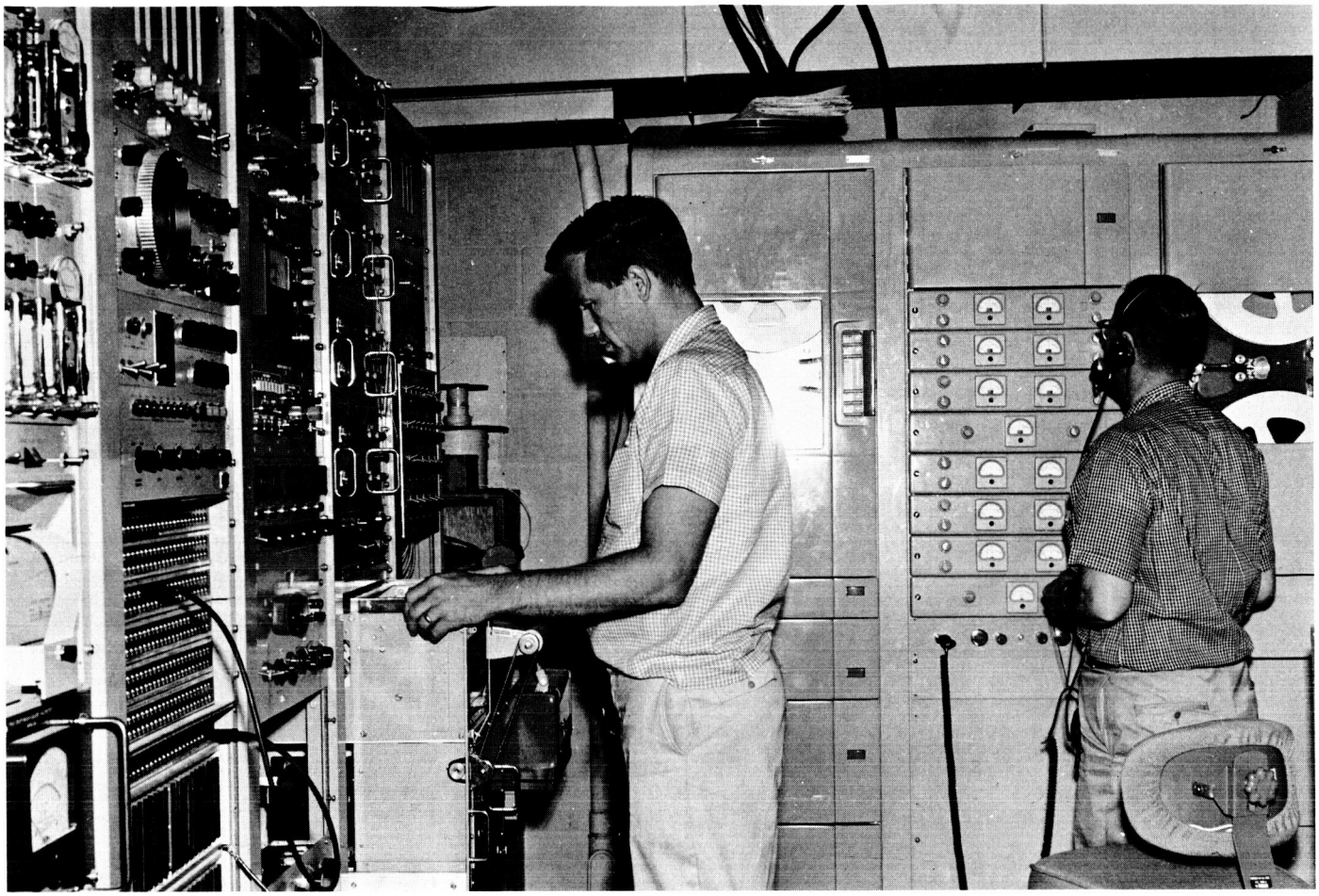


Fig. 20. Checkout of instrumentation and data handling systems at Goldstone Echo Station

After loss of lock by the MTS, an orbit was determined using the tracking data obtained from Antigua, Ascension, and the MTS. Acquisition information based upon this orbit was given the Goldstone Echo Station by the Central Computing Facility. Acquisition by this station at 093856Z confirmed that *Ranger 2* was still in a parking orbit.

Mechanical separation of *Ranger 2* and *Agena* was confirmed by *Agena* telemetry received at the AMR on Orbit 2. An extremely small amount of scientific telemetry was obtained in real time by the Johannesburg Station during Orbit 4. Some engineering telemetry was obtained in real time from the MTS and Johannesburg Station, enabling the Spacecraft Data Analysis Team to provide some information about spacecraft performance.

The DSIF pursued the task, as in the *Ranger 1* mission, of tracking and communicating with a low-altitude satellite. Woomera was secured, since the spacecraft would not be visible there until approximately 2300Z on 18 November. The other stations continued their tracking efforts until the spacecraft was no longer visible over their local horizons. Final contact with the spacecraft occurred at 1456Z, 18 November, at the MTS. The next scheduled acquisition by the DSIF was approximately 2310Z at Woomera, but no signal was heard. Subsequent searching by Woomera and Goldstone stations was unsuccessful and the *Ranger 2* tracking mission was terminated.

Because of the difficulties encountered in acquiring and tracking the spacecraft in the relatively brief view periods at each station, a 6-ft diameter parabolic antenna was mounted on the large reflector. The output of the antenna was connected to the receiver reference channel in a manner similar to that in the *Ranger 1* mission; and although the system gain was decreased by 20 db, a telemetry reception beamwidth of 10 deg was provided while the tracking bandwidth was left at approximately

1 deg. This acquisition aid was installed at the Woomera and Goldstone stations but was used only at the Goldstone Station for acquisition. It was not installed at the Johannesburg Station until after the spacecraft had stopped transmitting.

F. Performance Evaluation

Approximately 30 min of actual tracking time was recorded after the injection of *Ranger 2* into its parking orbit. The periods of tracking coverage, which occurred during the first five orbits only, are listed in Table 8. Periods of time during which the signal was lost in the middle of a pass are omitted from the table.

The longest individual tracking periods occurred during the 6.5-min pass over the MTS during both the second and third orbits. The MTS provided good engineering telemetry for all five passes, usually managed to keep its decommutator synchronized for all rates, and had a very low rate of teletype errors.

G. Participation of Non-DSIF Agencies

The AMR was assigned the responsibility of providing JPL with (1) orbital elements of the parking and transfer orbits and (2) acquisition angles for the Johannesburg, Goldstone Echo, and Mobile Tracking stations.

During the ascent phase, the *Atlas–Agena B* vehicle was tracked by the AMR. The AMR also established the parking orbit of the *Ranger 2* spacecraft using data from San Salvador rather than Antigua because of the poor quality of the data received from the latter. Excellent tracking data from Ascension Island were also received at the AMR and JPL in real time. (The preliminary indication that the second *Agena* burn did not occur was obtained from these data.)

Assuming a nominal second burn of the *Agena*, acquisition data for the DSIF were provided by the AMR prior to acquisition by Johannesburg and the MTS. (Mechanical separation of *Ranger 2* and *Agena* was confirmed by *Agena* telemetry received by AMR on the second orbit.)

Table 8. *Ranger 2* tracking coverage

Orbit	Station	Tracking period, GMT	Real time telemetry
1	Mobile Tracking	084438 to 085056	Yes
1	Johannesburg	084642 to 084656	No
1	Goldstone	093856 to 094446	No
1	Goldstone	094011 to 094021	No
2	Mobile Tracking	101708 to 102339	Yes
2	Goldstone	111400 to 111611	No
3	Mobile Tracking	115025 to 115653	Yes
4	Mobile Tracking	132252 to 132805	Yes
4	Johannesburg	132341 to 132908	Yes
5	Mobile Tracking	145629 to 150117	Yes

IV. *RANGER 3* MISSION

A. Flight Plan

Ranger 3 was the first flight aimed at lunar impact and had the following objectives:

a. Scientific experiments

(1) To obtain photographs of the Moon's surface.

(2) To collect gamma ray data both in flight and at the vicinity of the Moon.

(3) To receive lunar seismic data from a hard-landed capsule.

b. Engineering experiments

(1) To experiment with a trajectory error correction (midcourse maneuver).

(2) To experiment with a terminal maneuver.

(3) To further the development of spacecraft technology through performance evaluation of *Ranger 3*.

Although resembling *Ranger 1* and *2* in concept, the *Ranger 3* spacecraft (Fig. 21) was advanced in config-

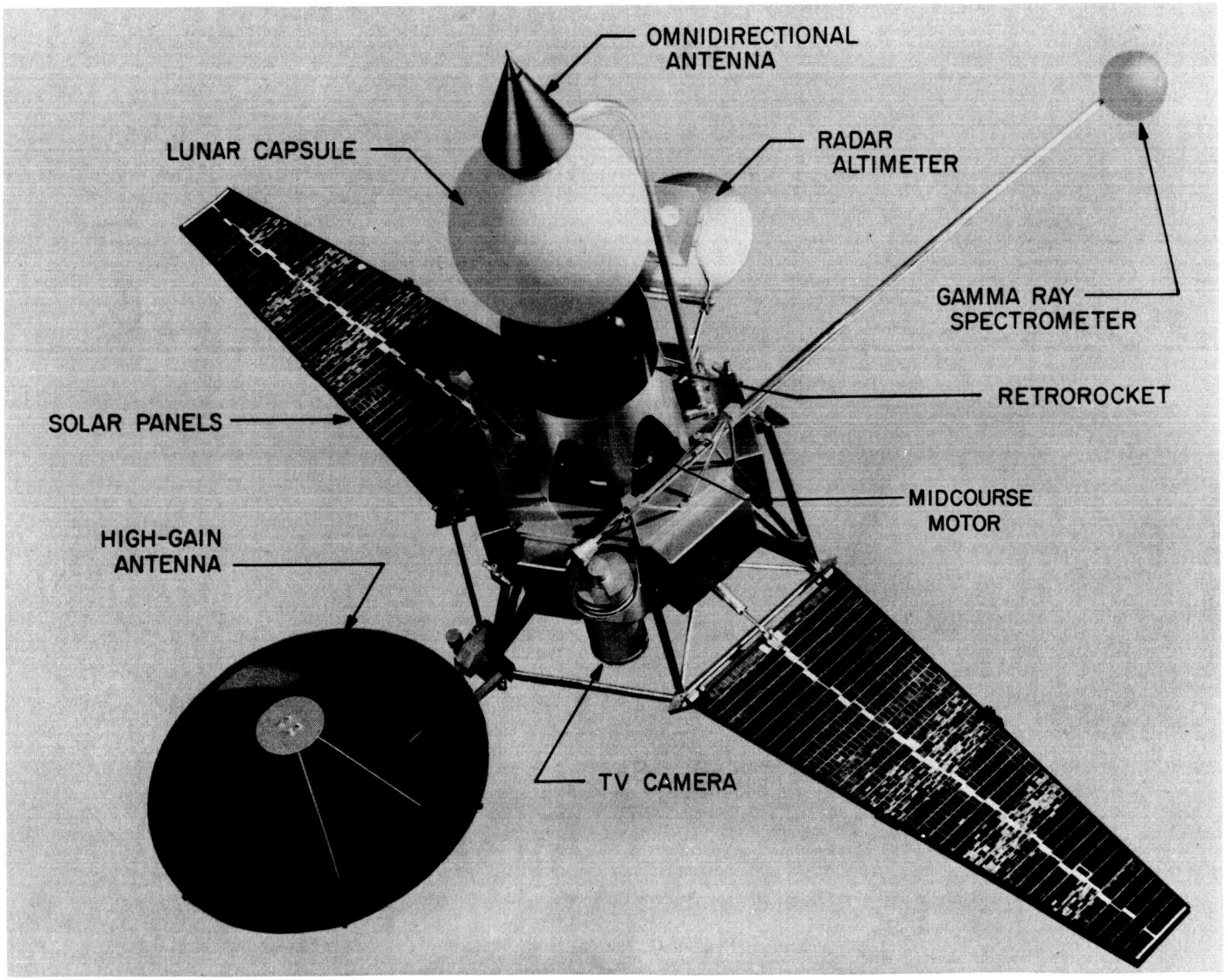


Fig. 21. *Ranger 3* spacecraft, showing equipment configuration

uration and capability. The new scientific instrumentation in *Ranger 3* consisted of a gamma ray spectrometer, a lunar seismometer, and a vidicon (TV camera). In addition, *Ranger 3* was the first spacecraft to carry a lunar capsule (Fig. 22).

The spacecraft was to be confined within its thermal shroud for environmental protection during the launch phase. The shroud was to be ejected after the sustainer burnout, and at the conclusion of the first *Agena* burn, the spacecraft was to be in a coasting or parking orbit. A second ignition and burn of the *Agena,* concluding with spacecraft injection, was to be followed by the separation of *Ranger 3* from the *Agena B.*

After separation, the spacecraft's Sun and Earth acquisition sequence would be initiated. The attitude control system would be activated, the solar panels erected, and the high-gain antenna rotated to a preset hinge angle. Solar sensors controlling the attitude control jets were to point the spacecraft roll axis toward the Sun, thus placing the solar cell power system in operation. The spacecraft was to turn about the roll axis until the antenna beam lay in the plane defined by the spacecraft roll axis and the Earth. While maintaining the antenna beam in this plane, the Earth sensors were to command the antenna to move so that its propagation axis intersected the Earth, establishing a high-gain communication link. The spacecraft would then continue to coast in the attitude of Sun and Earth acquisition.

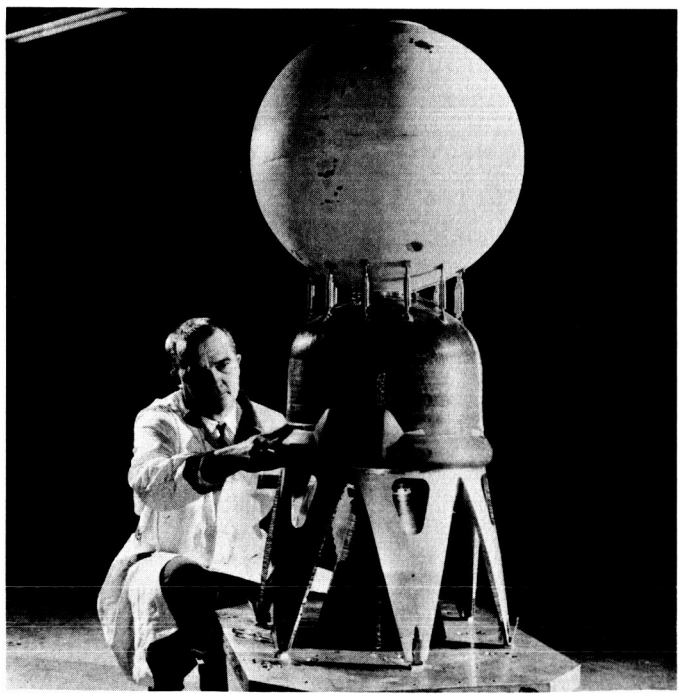


Fig. 22. *Ranger 3* lunar capsule atop retrorocket

After a suitable tracking period, the required trajectory corrections would be computed and the corrective maneuver commands transmitted to the spacecraft. The resulting midcourse maneuver would turn the spacecraft through the prescribed angles, supply the necessary thrust correction, and then return the spacecraft to its Sun and Earth orientation. Upon approaching the lunar surface, a terminal maneuver would be performed to align the vidicon camera for television pictures of the Moon, and to orient the lunar landing capsule for its subsequent separation and retrobraking. Commands from the Earth would initiate the terminal maneuver.

Upon a signal from the radio altimeter, the capsule spin-motor would fire, simultaneously spinning the capsule and lifting it out of its support structure approximately 2 ft. At this time, the capsule retromotor would reduce the capsule approach velocity of approximately 9000 to 0 ft/sec in 10 to 12 sec. Thus, during the final phase of its descent, the capsule was to be in free fall, impacting the Moon with a velocity of approximately 100 ft/sec. The spacecraft was to travel along a trajectory of its own and impact the Moon.

The scientific and engineering experiments placed aboard *Ranger 3* are listed in Table 9.

B. Mission Synopsis

Ranger 3 was launched by an *Atlas–Agena B* vehicle from Cape Canaveral on 26 January 1962 at 203011Z. It was the first attempt by the United States to take close-up pictures of the Moon and to make measurements on the lunar surface. A failure in the *Atlas* ground guidance system resulted in a late booster cutoff; and with no compensating control over the sustainer cutoff time, excess velocity accumulated.

Two programmed *Agena B* burning periods followed and the spacecraft was put into orbit with too much injection energy for Moon interception. The injection energy was considerably greater than that which the midcourse maneuver propulsion system was designed to correct; and as a result, *Ranger 3* arrived in the vicinity of the Moon some 14 hr ahead of schedule. On 28 January at 232240Z, the spacecraft passed in front of the Moon, missing it by 22,862 mi, and then went into orbit around the Sun. The possibility of a successful lunar impact mission was lost early in the flight.

Table 9. *Ranger* 3 scientific experiments

Experiments	Purpose
Primary:	
Lunar photography	To photograph the lunar surface from an altitude ranging from 2400 to 15 mi during spacecraft post-terminal maneuver descent.
Gamma ray measurement	To determine the material content of the lunar surface and acquire in-flight knowledge of the gamma ray intensity and distribution along the spacecraft trajectory.
Lunar seismic activity	To detect lunar structural noises and provide data which could be used to determine the nature of the lunar structure.
Secondary:	
Attitude correction device	To evaluate a controllable impelling force which could be utilized for inflight trajectory corrections and to maintain the attitude of the spacecraft during flight.
Utilization of pneumatic power	To evaluate the use of pneumatic power for the extension of the gamma ray boom.
Radio altimeter experiment	To determine the lunar attitude of the spacecraft by transmitting RF signals to the Moon and monitoring the reflected signals.

Operation of the spacecraft from launch until the start of the terminal maneuver appears to have been remarkably successful. All functions were successfully performed. The attitude control system acquired both the Sun and Earth without difficulty. Communication with the DSIF through the high-gain antenna was successfully established by ground command. The nonstandard trajectory of *Ranger 3* was such that the capability of the midcourse maneuver propulsion system could not effect any substantial change.

The midcourse maneuver, executed as an engineering experiment, attempted to optimize the position of the spacecraft for a vidicon experiment. The command to execute the midcourse maneuver was transmitted from the Goldstone Echo Station at 1000Z on 27 January. The spacecraft correctly executed the command; however, the maneuver was not the maneuver expected because of an ambiguity in the command sign convention. After the midcourse maneuver, the spacecraft proceeded to acquire Sun-lock and Earth-lock.

The attitude control system successfully reacquired the Sun and Earth after completion of the maneuver sequence. All commmands were carried out at the proper time. The only exception to normal performance occurred in the transmitter and cable that drove the omni-antenna. The power radiated from the spacecraft transmitter was approximately 12 db below the nominal value. Some telemetering of the midcourse maneuver was lost partly because of this abnormality and partly because of the very low antenna gain resulting from the attitude of the spacecraft during the maneuver.

The terminal maneuver command was sent at 172139Z on 28 January and would have allowed a viewing period for the television experiment of approximately 41 min just prior to the end of the second Goldstone pass. The terminal maneuver would have oriented the spacecraft so that the vidicon field of view covered a well-lighted area of the far side of the Moon not previously photographed. The terminal sequence included the rotation of the spacecraft to the desired orientation, the exposure of the vidicon, and the taking of pictures. The vidicon apparently operated, and the telemetry system apparently transmitted the vidicon output; however, the spacecraft attitude control system malfunctioned during the terminal maneuver, which resulted in the vidicon not being pointed at the Moon and the directional antenna losing its Earth orientation shortly after the first pitch turn started. Consequently, the received signal strength dropped about 30 db causing the vidicon signal to be obscured by noise. The spacecraft then began uncontrolled tumbling, exhausted its battery power, and operated intermittently whenever solar power happened to be generated by the solar panels seeing the Sun.

The DSIF provided tracking and telemetry coverage continuously for five days except for periods when the RF signal was nonexistent or too weak to recover. The spacecraft signal was lost at 1854Z on 31 January, shortly after the supply of gas used for attitude stabilization was exhausted, at an approximate distance of 452,000 statute mi from Earth.

C. *DSIF Configuration*

1. Station Equipment

The following paragraphs describe the mission-oriented equipment installed throughout the DSIF for the *Ranger 3* mission. The overall equipment configuration for each station is illustrated in Fig. 23–26.

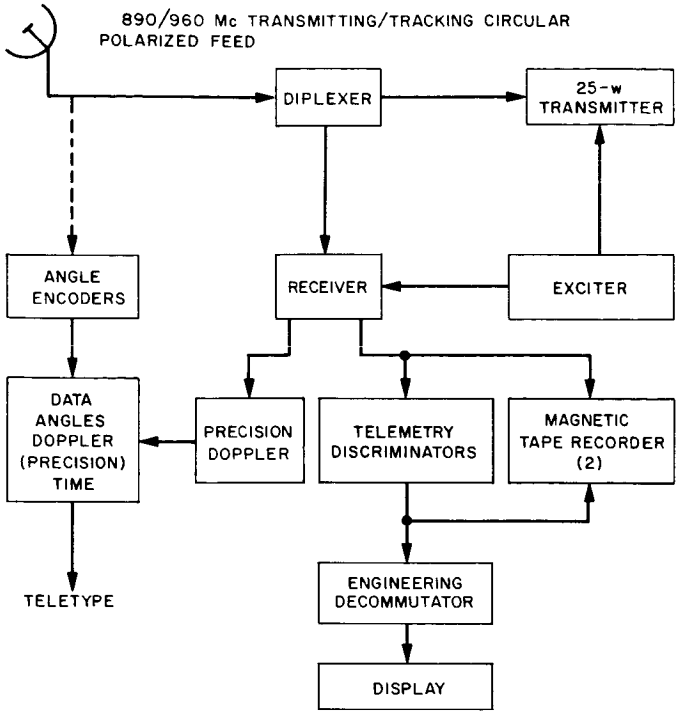


Fig. 23. Mobile Tracking Station equipment configuration for *Ranger 3*

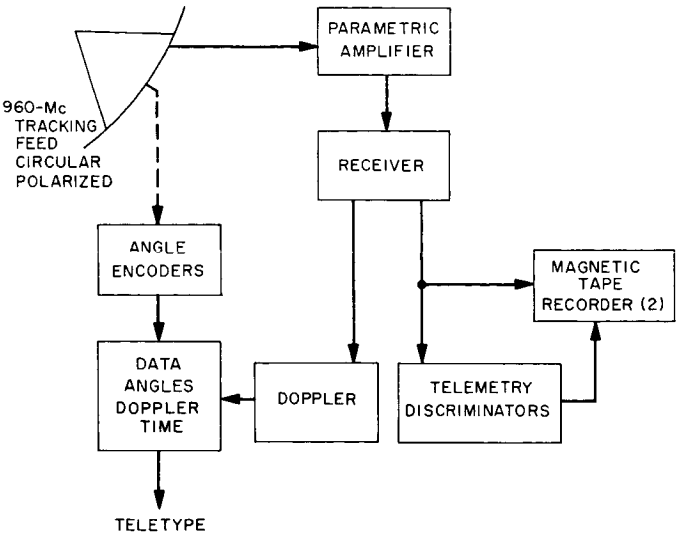


Fig. 25. Woomera Station equipment configuration for *Ranger 3*

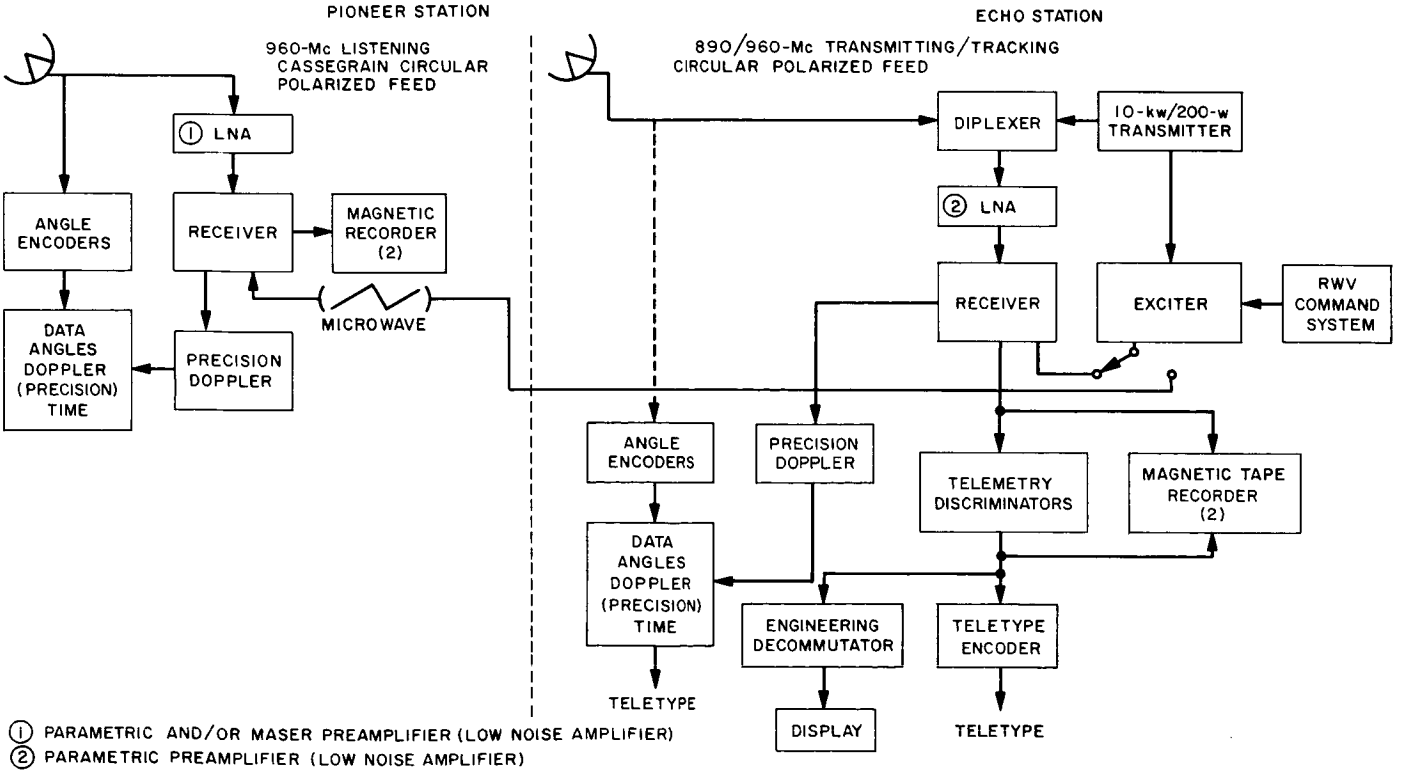


Fig. 24. Goldstone Station equipment configuration for *Ranger 3*

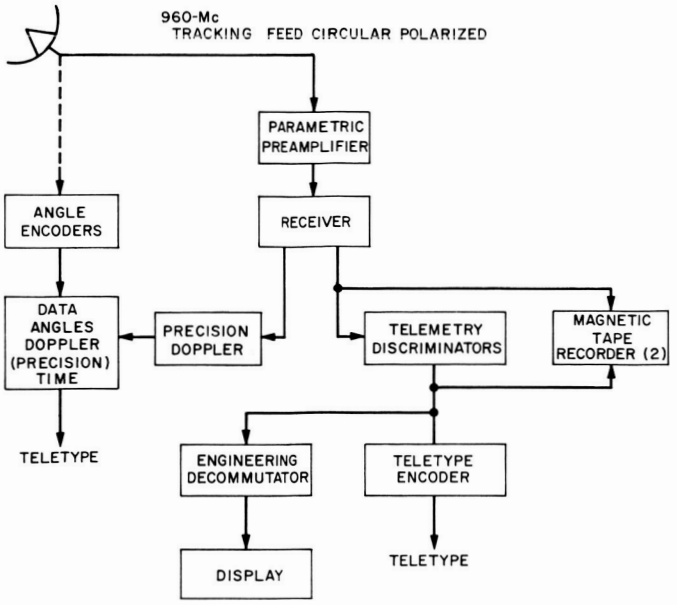


Fig. 26. Johannesburg Station equipment configuration for *Ranger 3*

Engineering telemetry teletype encoder. Engineering telemetry teletype encoders were installed at the Johannesburg and Goldstone Echo stations. The encoder converted the engineering telemetry decommutator output to a suitable format for direct teletype transmission.

Read-write-verify (RWV) system. The RWV system installed at the Goldstone Echo Station was a self-checking command processing system designed to accept information from a punched tape reader and to provide outputs to external equipment for sending command information to the space vehicle.

Vidicon experiment equipment. The wide-band telemetry outputs of both Goldstone receivers were selectively available at the inputs of the discriminators at the Goldstone Echo Station. Data from the Goldstone Pioneer Station (Fig. 27) were sent via the microwave link to the Echo Station. If the quality of the vidicon picture turned out to be poor, the output of the second receiver could be coupled into the telemetry discriminators.

Acquisition aids. The Johannesburg Station L-band acquisition system experiment was designed to evaluate the use of an auxiliary antenna for spacecraft acquisition. The function of the system was to provide detection and automatic angular acquisition of a spacecraft within the beamwidth of the acquisition antenna. In addition, the experiment was to provide information required for

Fig. 27. Goldstone Pioneer Station

the development of an S-band acquisition system. The experimental acquisition system consisted of a quadhelical array with a comparative circuit, console control panel, and associated circuitry.

An acquisition aid was also installed at the Woomera Station to accommodate the variety of trajectories that could be encountered during the *Ranger 3* mission. This acquisition aid was used for the first hour of the first day of tracking and consisted of the collimated 6-ft calibration antenna connected in parallel with the Σ (sum) channel of the 85-ft antenna system.

2. Interstation Communications Net

The communications net for the *Ranger 3* mission was identical to that used in *Ranger* missions 1 and 2 except for a line to the Space Technology Laboratories' (STL) computer which substituted for the Rand Corporation's computer as a back-up to JPL's computer.

Three full-period 60-wpm full duplex teletype circuits were conferenced directly into the DSIF communications net for transmission of telemetry and tracking data to the STL computer. These circuits were required for the first 24 hr of the mission when the computer was performing parallel computations of the postinjection

spacecraft orbit, the midcourse maneuver, and associated commands. The circuits were also required during the period ending either with lunar impact or at 72 hr after injection during which time the computer was on standby.

D. DSIF Preparation for Mission

On 10 January 1962, the DSIF began checkout and preparation of station subsystems, concurrent with final preparation of the spacecraft itself (Fig. 28 and 29). A trailer containing equipment for recording video signals was rented and was located at the Goldstone Station. Operational readiness tests involving the entire DSIF were conducted on 16, 19, and 23 January. On 24 January the DSIF was "in the green" for the *Ranger 3* launch.

E. Tracking Operations

1. Launch to Midcourse Maneuver Phase

Launch of the spacecraft occurred at 2030Z on 26 January and the DSIF experienced no difficulty in acquiring and tracking the spacecraft (Ref. 1). The spacecraft was initially acquired by the MTS at 2055Z and by Johannesburg at 2056Z. From launch to injection, no downrange data were supplied by AMR due to critical equipment failures. Personnel in the Space Flight Operations Center generated the initial DSIF acquisition information using the time of flight and a nominal trajectory. At these times, the spacecraft was radiating through the omniantenna; and the received signal strengths, as measured at the MTS and Johannesburg, were approximately −114 and −104 dbm, respectively.

As the spacecraft continued away from Earth, the received signal strengths gradually decreased. At 215000Z the signal strength at the MTS had decreased to −143 dbm, and at this station telemetry data could no longer be recovered from the signal. Shortly before this, at approximately 2127Z, Woomera acquired and continued tracking until 014230Z on 27 January when the spacecraft "set" below the station horizon. During this period, the spacecraft signal levels were −146, −126, and −131 dbm as measured at the MTS, Woomera, and Johannesburg, respectively.

After the initial acquisition, the MTS and Johannesburg continued tracking until approximately 1000Z on 27 January or about 1-1/2 hr after acquisition at the Goldstone Station. The MTS and Johannesburg Station, during their tracking periods, obtained tracking and telemetry data. These data were used to determine the spacecraft orbit and to evaluate the spacecraft performance.

Approximately 1/2 hr after the spacecraft rose above the Goldstone Station horizon, and while the MTS and Johannesburg Station were still tracking, a command was transmitted to the spacecraft switching the transponder signal from the omniantenna to the high-gain antenna. This switchover caused an immediate increase of about 28 db in the received signal strength, sufficient to allow the MTS once again to record telemetry.

By the time the spacecraft was acquired at the Goldstone Station it was apparent the orbit was nonstandard. The spacecraft would neither hit nor pass close to the Moon during a Goldstone Station visibility period–the latter precluding the possibility of obtaining TV pictures of the lunar surface.

2. Midcourse Maneuver to Terminal Maneuver Phase

In addition to carrying a vidicon system and gamma ray and lunar seismometer experiments, *Ranger 3* also incorporated equipment enabling the spacecraft to perform midcourse and terminal (preimpact) maneuvers. The midcourse maneuver would adjust the spacecraft orbit, and the terminal maneuver would orient the vidicon camera toward the lunar surface to activate a radar altimeter. This altimeter would, at a preset altitude, fire a retromotor to separate the seismometer experiment from the spacecraft and decrease its velocity, allowing the impact limiting capsule enclosing the experiment to survive lunar impact.

Since the extent of the corrective maneuver required to obtain a lunar impact was beyond the capability of the maneuver system, a fly-by maneuver was chosen as the alternative, and the necessary commands were generated by the Space Flight Operations Center. These commands ensured that the spacecraft would pass in the vicinity of the Moon during a Goldstone Station visibility period.

After the spacecraft signal was switched to the high-gain antenna, preparation of the spacecraft for the midcourse maneuver began. The three stored commands defining the midcourse maneuver were transmitted at 1-min intervals. The first command was transmitted at 0923Z and the last command was transmitted at 0925Z. Successful reception was indicated by spacecraft telemetry.

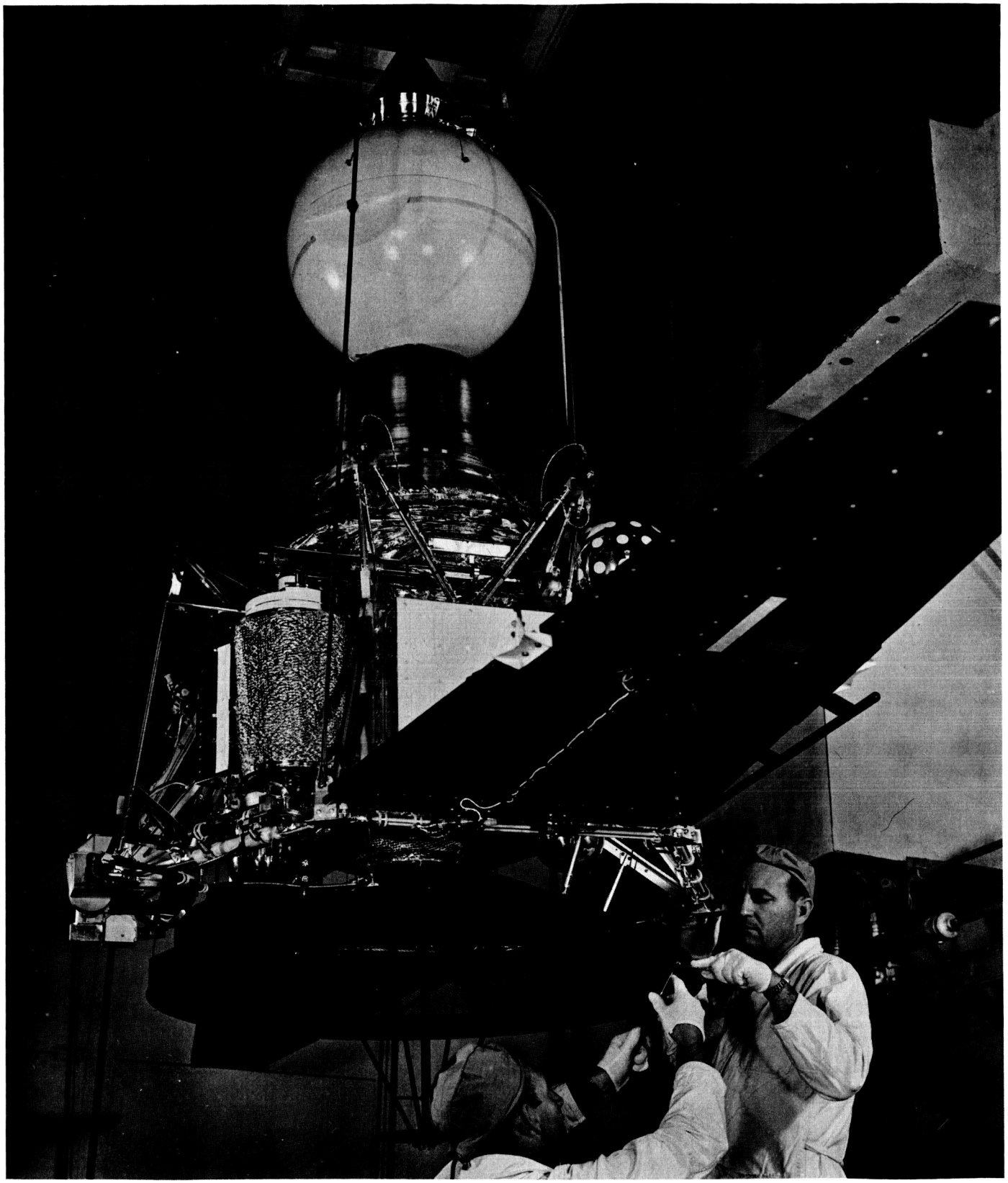


Fig. 28. Final assembly and adjustment of *Ranger 3* parabolic antenna

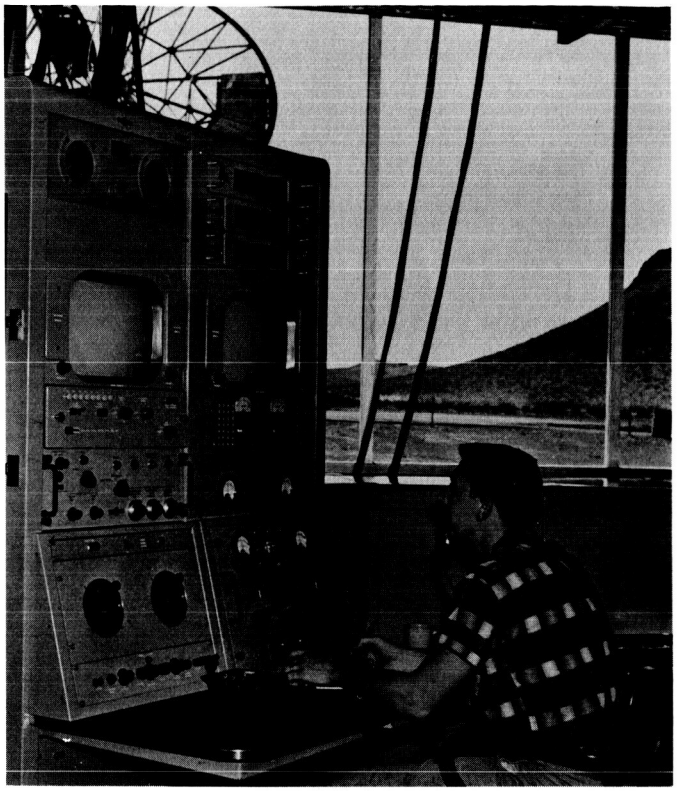


Fig. 29. Checkout of servo and video monitoring equipment at Goldstone Pioneer Station

Prior to the transmission of the midcourse maneuver initiate command, one final preparatory command, the antenna switchover command, was transmitted at 0955Z and caused the output of the transponder to switch from the high-gain (directional) antenna to the omniantenna. This switchover dropped the received signal strength from −110 to −145 dbm but enabled communication to be maintained with the spacecraft while it was engaged in the attitude changes required for the midcourse maneuver.

The midcourse maneuver initiate command was transmitted from the Goldstone Echo Station at 1000Z on 27 January. Although the maneuver was initiated somewhat earlier than planned, the command was generated, checked, and transmitted to the DSIF with no difficulties or holdups. Response of the spacecraft was detected immediately by a change in the type of telemetry being transmitted. (During the midcourse maneuver, some of the important telemetry was different from that received during the cruise portion of the flight.) Goldstone continued tracking the spacecraft during the maneuver until, at 1015Z, the Echo receiver lost the signal when the spacecraft presented an unfavorable portion of the omniantenna pattern toward the Earth. Two and one-half minutes later, Pioneer also lost lock. Both stations had reacquired the signal by 1020Z, but the signal strengths were so low (−153 dbm at the Echo Station and −160 dbm at the Pioneer Station) that no telemetry could be recovered. At 1030Z, as the spacecraft continued to change aspect, the signal strength began increasing, and by 1040Z, all telemetry was again being recorded. However, by this time, as scheduled in the maneuver sequence, the telemetry transmission mode had cycled to the cruise mode.

After reacquisition, the Goldstone Pioneer and Echo stations continued tracking with the received signal level of −145 dbm. At 1137Z, after the spacecraft reacquired the Sun and Earth (insuring proper pointing of the high-gain antenna), the antenna switchover command was sent to the spacecraft, raising the signal level to −112 dbm. Shortly thereafter the Pioneer Station conducted a search for the seismometer capsule signal.

Unfortunately, during the reacquisition phase, elements of the DSIF doppler readout subsystem dropped phase lock. Inadequate monitoring permitted this condition to go undetected for several hours and doppler data during this period was invalid.

A signal at the capsule frequency (960.15 Mc) was detected and the receiver "locked up" on a received signal of −150 dbm. The Pioneer Station listened to the capsule transmission until 1311Z, when tracking of the transponder signal was resumed.

The DSIF continued its tracking and telemetry recording program. The Woomera Station and then the Johannesburg Station each successively acquired and tracked the spacecraft until it "set" below their respective horizons.

Soon after the Johannesburg Station acquired the spacecraft, the MTS was also requested to track the spacecraft. The MTS is normally not required to track after its initial view period; however, because the doppler discrepancy by this time had been discovered in the postmidcourse doppler data from the Goldstone Echo Station, it was necessary to reactivate the MTS to obtain valid data as soon as possible. Aside from the Goldstone Echo Station, the MTS was the only station which had a transmitter, and therefore was the only other station capable of providing doppler data of sufficient accuracy to allow an accurate postmaneuver orbit to be determined. The time for transmission of the terminal maneuver command could not be determined until an accurate postmaneuver orbit could be computed.

3. Terminal Maneuver Phase

The MTS acquired the spacecraft signal at 042349Z, the spacecraft transponder acquired the MTS transmitter, and the tracking system was "locked up" in the two-way mode. The received signal strength held fairly steady at approximately −131 dbm. At 084500Z, tracking was interrupted to allow the spacecraft transponder to acquire the Goldstone transmitter. At 084909Z, after the Goldstone tracking system was "locked up" in a two-way doppler condition, the MTS resumed tracking. The transmitter was shut down, however, since the spacecraft was now locked on the Goldstone Station's transmitter signal. At 104012Z, the spacecraft "set" below the MTS horizon and tracking was terminated. After successful two-way acquisition by the Echo Station at 084703Z, both Goldstone stations tracked until lock was lost during the spacecraft terminal maneuver.

Preparation for the terminal maneuver began with the transmission of three required stored commands at approximately 1-min intervals, at 162941Z, 163042Z, and 163146Z. The terminal maneuver initiate command was transmitted from the Echo Station at 172139Z. When the spacecraft began the terminal maneuver received signal strengths held steady at −118 dbm at Echo Station and −111 dbm at the Pioneer Station. However, at 172821Z, signal strength began decreasing, and by 173204Z, both stations had lost lock. Reacquisition attempts were not immediately successful but, by 173918Z, both stations had reacquired the signal. Signal strength, however, had deteriorated and was fluctuating at both stations (−145 to −149 dbm at the Pioneer Station and −149 to −153 dbm at the Echo Station).

This decrease in signal strength meant that reception of TV pictures of the lunar surface would be impossible. In an attempt to improve the signal from the spacecraft, several commands were sent from the Echo Station (Table 10) without success. Therefore, at 183620Z, the spacecraft telemetry mode was changed to the cruise mode and attempts to retrieve any television pictures were terminated at all stations. (The Woomera Station had been tracking the spacecraft since 150100Z.) Before the spacecraft passed below the Goldstone horizon at 185200Z, a roll override command was sent to the spacecraft at 183750Z, disorienting the spacecraft from its terminal maneuver attitude and increasing the signal strength slightly at Woomera.

Table 10. Sequence of commands transmitted to improve the received signal strength during *Ranger* 3 terminal maneuver

Time, GMT	Command
180517	Switch transponder signal to omniantenna
181105	Switch transponder signal to high-gain antenna
181343	Change hinge angle of high-gain antenna
181700	Switch transponder signal to omniantenna
182300	Switch transponder signal to high-gain antenna

4. Postterminal Maneuver Phase

After the unsuccessful terminal maneuver, the DSIF continued tracking the spacecraft. However, problems soon developed with the received signal. During the period following the terminal maneuver at 230100Z, while the Woomera and Johannesburg stations were tracking, the transponder signal disappeared. Momentary signals were heard by the Woomera Station until 232800Z. After disappearance of the signal, the stations alternated periods of capsule tracking with periods of searching for the transponder signal. The transponder signal was not reacquired until 053418Z, after the spacecraft had "set" below the Woomera horizon.

After reacquisition, the transponder signal developed a periodic dropout condition. After every 13 sec, the signal would disappear, a condition that did not exist when the spacecraft was being tracked in the two-way mode.

Additional attempts were made to command the spacecraft from Goldstone. On 29 January, an attempt was made, using the midcourse maneuver command addresses, to initiate a maneuver by transmitting three stored commands and an initiate command. No response was observed.

On the following day, the equipment configuration at the Goldstone Station was modified to allow the transmitted power to be increased from 200 w to 7 kw, which required that the tracking feed be replaced with the transmitting feed. Since auto tracking was no longer possible without the tracking feed, both antennas were positioned by the coordinate converter computer. Intensive attempts to command the spacecraft culminated in the transmission of 211 commands (alternate roll override and telemetry mode change commands) without any effect on the spacecraft.

On the following day, 31 January, twenty antenna switchover commands were transmitted. The modulation

frequency was varied for these commands, but no response was obtained from the spacecraft. At the conclusion of the tracking period on 31 January the Goldstone Echo Station ceased participation in the *Ranger 3* mission.

Between tracking periods at the Goldstone stations, the Woomera and Johannesburg stations continued tracking. Signal strengths were approximately −130 to −140 dbm. During the final tracking period at the Goldstone Echo Station, the spacecraft signal deteriorated. The average level was −140 dbm, but there was a continual variation of ±20 dbm about this average. The spacecraft signal continued to deteriorate and by the time the Woomera Station acquired on 1 February, only momentary locks of 1-min duration were possible. At this time, the stations began alternately searching, for half-hour periods, for either the seismometer capsule signal or the transponder signal, but only momentary locks were obtained. The Johannesburg Station and Goldstone Pioneer Station were then instructed to secure from tracking attempts. The Woomera Station, however, continued to attempt signal acquisition at weekly intervals until 14 March, but no signal was heard at any time. The Johannesburg Station attempted signal acquisition on 21 and 29 March without success and then secured from further mission activities.

F. Performance Evaluation

The recovery of spacecraft telemetry during the *Ranger 3* mission was generally very successful. Except for periods when the spacecraft signal was seriously degraded by nonstandard spacecraft performance, the telemetry recorded by the DSIF provided complete coverage of the mission for postflight analysis.

1. Engineering

Near-real time engineering telemetry from the Johannesburg and Goldstone Echo stations proved adequate during cruise modes, especially in monitoring the acquisitions. However, loss of signal during the midcourse and terminal maneuvers precluded adequate evaluation of spacecraft performance from real time data at those times. Lack of decommutator synchronization for slow rate measurements was a common problem whenever the spacecraft signal was noisy, but this was anticipated. The performance of the teletype encoders was quite satisfactory, particularly at the Goldstone Station. A defective puncher at Johannesburg resulted in a number of bad data samples, but the volume of good data compensated for that shortcoming. The telemetry event data reported by the DSIF proved to be quite sufficient and dependable.

2. Vidicon Experiment

Vidicon pictures were printed directly from Goldstone telemetry tapes. These pictures showed that the telemetry was correctly commutated and decommutated from the vidicon, that both shutter and erasure cycles operated properly, and that there were no horizontal or vertical drifts.

3. Extensions and Firing Event Pulses

The solar panels, gamma ray boom, and omniantenna were noted to extend at the correct time. No verification of the radar altimeter extension was obtained although the event channel was in lock at the time.

All squib firing event pulses were noted on the recovered telemetry except the one for midcourse motor ignition. The only abnormalities associated with any of these were the transmitter failure at the time the solar panels were extended and the lack of confirmation of altimeter extension. Telemetry gave no indication of what happened to the altimeter.

4. Midcourse Maneuver

Recovery of spacecraft telemetry during the latter part of the midcourse pitch turn maneuver, the motor firing, and the start of Sun reacquisition was seriously hindered because the spacecraft was commanded to an orientation beyond the omniantenna constraint. This was a calculated risk decided upon during the operation that was complicated by the spacecraft turning in the direction opposite to the one predicted.

5. Angle Data Evaluation and Investigation

Pointing data from Woomera and Johannesburg stations were corrected for the errors detected in star tracks and compared with similar pointing angles determined from the computed orbit. The error remaining was attributed to RF boresight shifts due to all causes (star-track determined corrections compensated for mechanical pointing errors).

Two other probable causes of RF boresight error were determined:

a. Thermal structure deformation of the antenna because of changing ambient temperatures.

b. Gravity induced deflections of the feed quadripod structure because of the changing antenna attitude.

6. Doppler Data Evaluation

Doppler data from the *Ranger 3* mission allowed evaluation of a doppler error model which was found to adequately describe the two-way doppler standard deviation by considering four causes:

a. Doppler counter round-off.

b. Transmitter reference oscillator drift.

c. Gaining or losing a cycle in a random fashion in either the ground receiver or the spacecraft receiver because of noise.

d. Noise on the signal due to the transmission medium.

Two phenomena most apparent in the doppler data from the MTS were identified as:

a. Systematic error because of the round-off mechanism of the doppler counter.

b. An apparent ½-cps jump because of doppler data round-off.

These phenomena were not quite as apparent in the doppler data from the Goldstone Echo Station because a different sample rate and a different averaging time were used there.

7. Signal Strength

While tracking *Ranger 3*, signal strength discrepancies of from 3 to 10 db occurred between stations, the most striking of which was an 8- to 10-db difference between the Goldstone Pioneer and Echo stations. This difference was attributed to:

a. Incorrect values of cable calibration.

b. Superseded procedures used in setting the parametric amplifier gain.

c. Use of a transponder with an incorrect dial calibration.

A discrepancy also occurred during the midcourse maneuver when the Goldstone Pioneer Station tracked a sideband. Other discrepancies are attributed to the human element in calibration procedures.

8. Equipment Problems

The following paragraphs summarize the equipment problems encountered at each DSIF station during the *Ranger 3* mission.

Mobile Tracking Station. In an attempt to eliminate excessive tracking jitter, 4-db pads were inserted in each receiver error channel, and an improvement of about 50% was observed. The choice of inverters or generators did not seem to be critical.

There were no other equipment problems at the MTS, except for a lost stylus on channel 6 of the Sanborn Recorder for approximately 3½ min during the tracking operation.

Goldstone Pioneer Station. During the third tracking period, the prototype parametric amplifier failed. There was some question from the beginning as to whether it would last through the entire mission. A new production unit was installed in time for the next tracking period.

During the *Ranger 3* mission, the possibility was proved of attaining a good lock of the transmitter reference loop in two-way mode with the 31-Mc voltage controlled oscillators (VCOs) at the Goldstone Pioneer and Echo stations tuned to different frequencies.

Prior to the mission, it was noted that the method by which the Goldstone Echo Station transmitter VCO frequency was to be monitored might not be satisfactory in the event of a nonstandard operation. The X-30 digital multiplier has a bandwidth of approximately 1 to 5 kc, and if the transmitter VCO were to go positive from its center frequency of 29.668212 Mc, the input to the X-30 would follow from 1614 cps to a higher number and all would be correct. However, if the transmitter VCO were to go negative from its center frequency, the doppler number to the X-30 would fall below 1 kc and the X-30 could not lock up. Since the computer had already been programmed, however, no changes could be made.

As it happened, the transmitter VCO had to be tuned well below its center frequency during the mission. The doppler number to the X-30 multiplier was below 1 kc and the X-30 would not lock. The operations center was informed of this prior to each of the first three tracking periods, and it was requested that permission be granted to add a 3.3-kc bias. No reply was received. On the night of the fourth tracking period, a 3.3-kc

bias was added, without instruction, and a full explanation sent with the data printout to JPL in real time.

The following components or modules failed during active tracking operations:

a. The 30-Mc VCO in the doppler transmitter reference loop. The VCO was replaced.

b. The CMC counter No. 2 in the data doppler counter system. The failure was in the power supply generator but was not repaired until the end of the tracking period.

c. The X-15 multiplier in the doppler transmitter reference loop. The multiplier was replaced.

Goldstone Echo Station. During the station countdown on 31 January a noise in the 960.05-Mc receiver was discovered that disappeared when transmitter drive was turned off. The transmitter power output was varied from 7 kw downward to see if power levels had anything to do with the noise. Since the noise appeared to be less frequent at the lower power levels, power output was left at 1.5 kw.

A breakdown in the feed system was suspected because of the continuing high back power. To check for signs of arcing, the coaxial line was opened at different flanges. The back power did not show any indications of sudden changes, and the transmission line was purged with nitrogen and restored. When the waveguide at the apex was removed and checked no arcing was present. After completion of wave-guide inspection, the X-6 multiplier in the transmitter exciter was replaced. After driver power dropped to a 0.7-w output it was readjusted to 1.5-w output and the Klystron refocused. Transmitter power was 5 kw at 1550Z. Although the noise was still present, normal track was achieved until end of mission at 1929Z.

When the doppler data recorded at the Echo Station on 27 January were reduced, it was discovered that an error existed during approximately 4 hr of the tracking period. The computer accepted these data because the data flag was "good". The station log indicates that all loops were locked during the entire period that the doppler was incorrect.

Two possibilities were immediately investigated. The first possibility was that the spacecraft transponder may have acquired a sideband of the ground transmitter, which was being modulated during the time of reacquisition. Analysis of the doppler data shows that this could not have been the case. However, since this situation may occur during future operations, the following acquisition procedure will be initiated whenever any loss of lock occurs during two-way doppler mode:

a. Remove transmitter modulation.

b. Acquire one-way lock.

c. Acquire two-way lock.

d. Reapply transmitter modulation.

The second possibility was that one of the loops associated with the doppler data had dropped out of lock. These loops were investigated to establish that their design assures a reasonable margin of safety under the dynamic ranges encountered. Following an investigation of the feasibility of providing reliable visual indication to the operator of individual loop conditions, it was decided to provide him with a more definite indication of loop-lock than is presently available. Simultaneously, the interlocked information from all the loops will be added to the data condition format of the data system, and the "lock–unlock" condition will be recorded by the instrumentation system.

All of this will provide useful information for analyzing purposes if there should again be difficulty. Detailed information of this type is not presently available to aid in localizing or correlating the problem. Goldstone and subsequently Woomera and Johannesburg were equipped with necessary instrumentation to indicate the in-lock or out-of-lock condition of the pertinent loops in the doppler system. In addition, predicted doppler is now being sent just prior to the pertinent DSIF station pass so that the station manager can monitor the performance of the doppler loops.

Woomera Station. During the pass on 27 January the engineering telemetry teletype encoder failed. Engineering telemetry was then recorded on the digital printer for later manual transcription. In addition, a faulty mixer in the telemetry instrumentation system was replaced.

Johannesburg Station. On 30 January at 0104Z, the data systems clock malfunctioned but was back in operation by 013311Z.

Prior to the tracking mission beginning at 2231Z on 30 January the telemetry-to-teletype converter failed. The converter was repaired by 2300Z but the time readout was inaccurate. The time readout problem was corrected by 0040Z on 31 January. At 0117Z a galvanometer

was replaced in the Midwestern Recorder. At 0134Z a faulty circuit board was replaced in the data systems clock circuit.

G. *Participation of Non-DSIF Agencies*

1. Space Flight Operations Center

Since no downrange data were supplied by the AMR from launch to injection, personnel in the SFOC generated the initial DSIF acquisition information using the time of flight and a nominal trajectory. The orbit was determined to the desired level of accuracy at the times required. The nonstandard trajectory was recognized early enough so that sufficient evaluation of the alternative missions was possible.

For this flight, STL's IBM 7090 computer was used as a backup to the JPL Central Computing Facility. At no time was it necessary to use this backup capability.

2. Atlantic Missile Range

No radar data of the *Agena* parking orbit was received either by JPL or by the AMR (Impact Predictor Building) due to failure of communication equipment at San Salvador, Antigua, and Puerto Rico. No Twin Falls Victory tracking ship participation was expected. The data from only one of these sources, Antigua, were to be relayed to JPL in real time.

Because of a lack of information from uprange stations and the nonstandard trajectory, the Ascension Island radar did not acquire the *Agena* until about 10 min after injection (4 min after rise at South Africa). The data were received by JPL but were not used because (1) the MTS had already acquired the spacecraft, and (2) range ambiguities were present in the data.

The Ascension data had range ambiguities of 1,152,570 yd due to the 142-pps repetition rate. Reference to the JPL orbit for an estimate of the range indicated that 4 pulses or 4,222,435 km should be added to the reported range. These data occurred after the *Agena* retromaneuver; no attempt was made to remove the effects of this impulse to improve comparison with the JPL orbit.

The American Mariner ship acquired the *Agena* on schedule and obtained data on the early postinjection orbit, but, due to communication (atmospheric loss of communication at twilight) and operational difficulties on alternate transmission frequencies, the data did not reach JPL or Cape Canaveral in real time. Some hours later, these data were retransmitted to the Cape's Impact Predictor Building. Although these data were not used, a record copy was supplied to JPL which was subsequently analyzed.

V. *RANGER 4* MISSION

A. *Flight Plan*

Ranger 4 was the second flight aimed at lunar impact and had the same objectives as *Ranger 3*, which were:

a. Scientific experiments

(1) To obtain photographs of the surface of the Moon.

(2) To collect gamma ray data both in flight and at the vicinity of the Moon.

(3) To receive lunar seismic data from the hard-landed capsule.

b. Engineering experiments

(1) To experiment with a trajectory error correction (midcourse maneuver).

(2) To experiment with a terminal maneuver.

(3) To further the development of basic spacecraft technology through performance evaluation of the *Ranger* spacecraft.

The *Ranger 4* spacecraft was a duplicate of the *Ranger 3* spacecraft and included among its scientific instrumentation a gamma ray experiment, a lunar seismometer, and a vidicon. The spacecraft was confined within a thermal shroud for environmental protection during the launch mode. *Ranger 4* also had midcourse and terminal maneuver capability and a lunar hard-landing capsule. The scientific and engineering experiments placed aboard *Ranger 4* were the same as those carried by *Ranger 3* (Table 9).

The flight plan for *Ranger 4* is illustrated in Fig. 30. The thermal shroud was to be ejected after the sustainer burnout. At the conclusion of the first *Agena* burn, the spacecraft was to be in a coasting or parking orbit. A second ignition and burn of the *Agena,* concluding in spacecraft injection, was to be followed by the separation of the spacecraft from the *Agena B.*

The spacecraft's Sun and Earth acquisition sequence was to be initiated after separation, attitude control system activated, solar panels erected, and high-gain

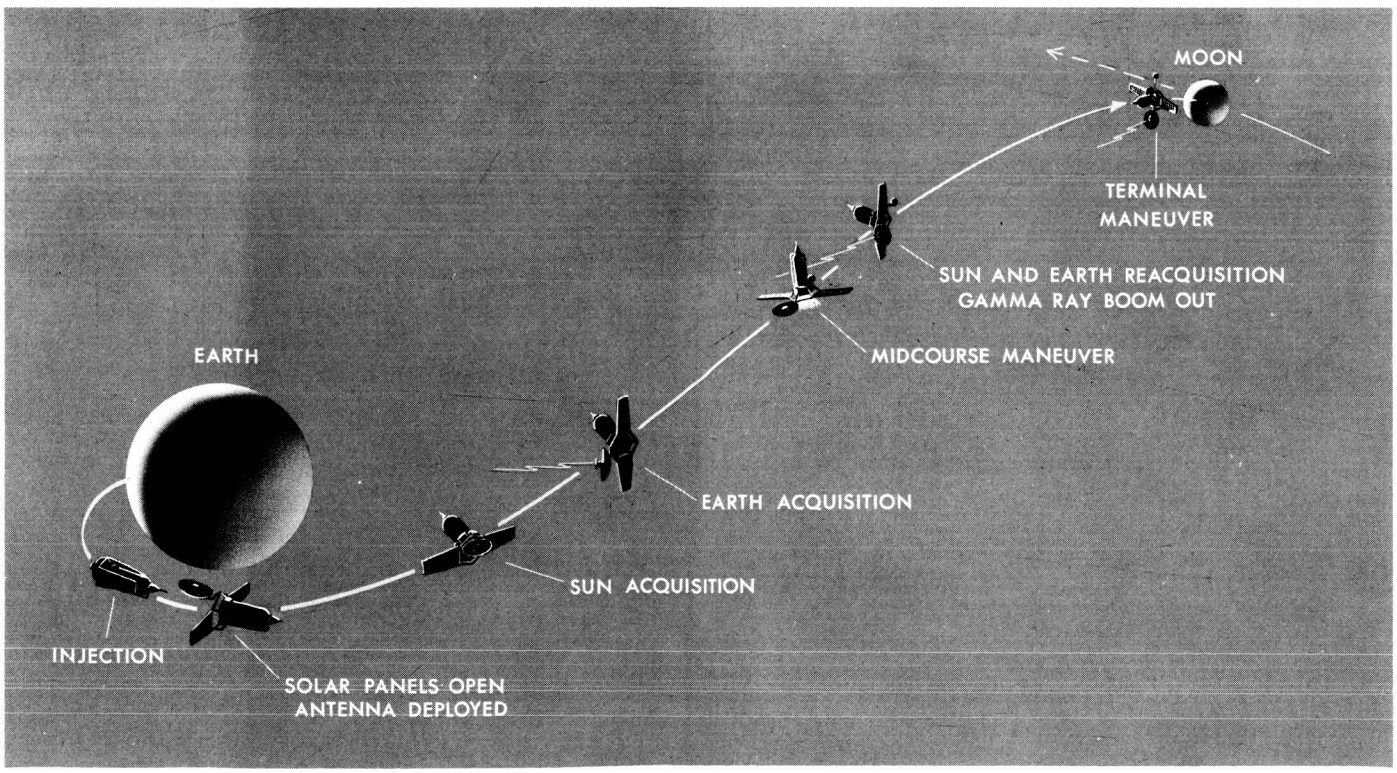


Fig. 30. *Ranger 4* flight plan

antenna rotated to a preset hinge angle. Solar sensors controlling the attitude control jets were to cause the spacecraft to point its roll axis toward the Sun, placing the solar cell power system in operation. The spacecraft would then turn about its roll axis until the antenna beam lay in the plane defined by the spacecraft roll axis and the Earth. Maintaining the antenna beam in this plane, the Earth sensors would command the antenna to move so that its propagation axis intersected the Earth, establishing the high-gain communication link. The spacecraft would then continue to coast in the attitude of Sun and Earth acquisition.

After a suitable tracking period, the required trajectory corrections were to be computed and the corrective maneuver commands transmitted to the spacecraft. The resulting midcourse maneuver would turn the spacecraft through the prescribed angles, supply the necessary thrust correction, and return the spacecraft to its Sun and Earth orientation. Upon approaching the lunar surface, a terminal maneuver would align the vidicon camera for television pictures of the Moon and orient the lunar landing capsule for its subsequent separation and retro-braking. Commands from the Earth would initiate the terminal maneuver.

Upon a signal from the radar altimeter, the capsule spin-motor was to fire, simultaneously spinning the capsule and lifting it out of its support structure approximately 2 ft. At this time, the capsule retro-motor would fire and reduce the capsule's approach velocity of approximately 9000 to 0 ft/sec in 10 to 12 sec. Thus, during the final phase of its descent, the capsule would be in free fall and impact the Moon with a velocity of approximately 100 ft/sec. The spacecraft was to plunge along a trajectory, separate from that of the capsule, and impact the Moon.

B. Mission Synopsis

Ranger 4 was launched by an *Atlas–Agena B* vehicle from Cape Canaveral on 23 April 1962 at 205015Z. The AMR and mobile SMS tracked the spacecraft after lift-off and received good data. During this period, no abnormalities were noted and telemetry indicated that the spacecraft was operating normally. The SMS lost lock with the transponder at L + 460 sec with a signal of −135 dbm.

The first DSIF station to acquire, at about L + 25 min, was the MTS. During the time between loss of lock by the SMS and acquisition by the MTS, a malfunction, evidenced by a loss of channel 1 and a loss of modulation on channels 2, 3, 4, and B19, occurred in the spacecraft. Changeover to the high-gain antenna could not be made because it was impossible to command the spacecraft. Signal contact with the spacecraft was, therefore, confined to the omniantenna with lower signal levels, naturally. There was no telemetry decommutation for the mission except for that recovered by the AMR tracking network and the SMS. The malfunction in the spacecraft precluded the recovery of any scientific data.

During the transponder tracking period, no event blips or any other evidence of programmed commands were observed. Frequent change between "in-lock" and "out-of-lock" condition for the telemetry channels was a result of the low signal level aggravated by the spacecraft tumble.

The DSIF tracked the spacecraft transponder signal continuously from shortly after injection until the batteries supplying the power to the transponder were exhausted at 10 hr 32 min after launch. The DSIF then tracked the capsule signal until the spacecraft passed behind the Moon on 26 April at 1247Z. It is estimated, based on occultation time, that lunar impact occurred at 124941Z ± 3 sec. Target parameters at impact were computed to be selenographic latitude 15.5 deg S, selenographic longitude 229.5 deg E, bus impact speed 2.669 km/sec, and time of flight from liftoff to impact 63 hr, 59 min, and 38 sec.

Seven orbits were computed during the *Ranger 4* mission which were used to provide pointing data for the DSIF and to predict impact.

The capsule signal was lost two minutes before the spacecraft was occulted by the Moon. Space flight operations were continued to confirm that the spacecraft had impacted the far side of the Moon and did not pass beyond. With no signal being detected, tracking operations were discontinued at 1330Z on 26 April.

C. DSIF Configuration

The special equipment installed for the *Ranger 3* mission was used in the *Ranger 4* mission also. Station equipment configurations for the *Ranger 4* mission are illustrated in Fig. 31–35.

The communications net for the *Ranger 4* mission is shown in Fig. 36.

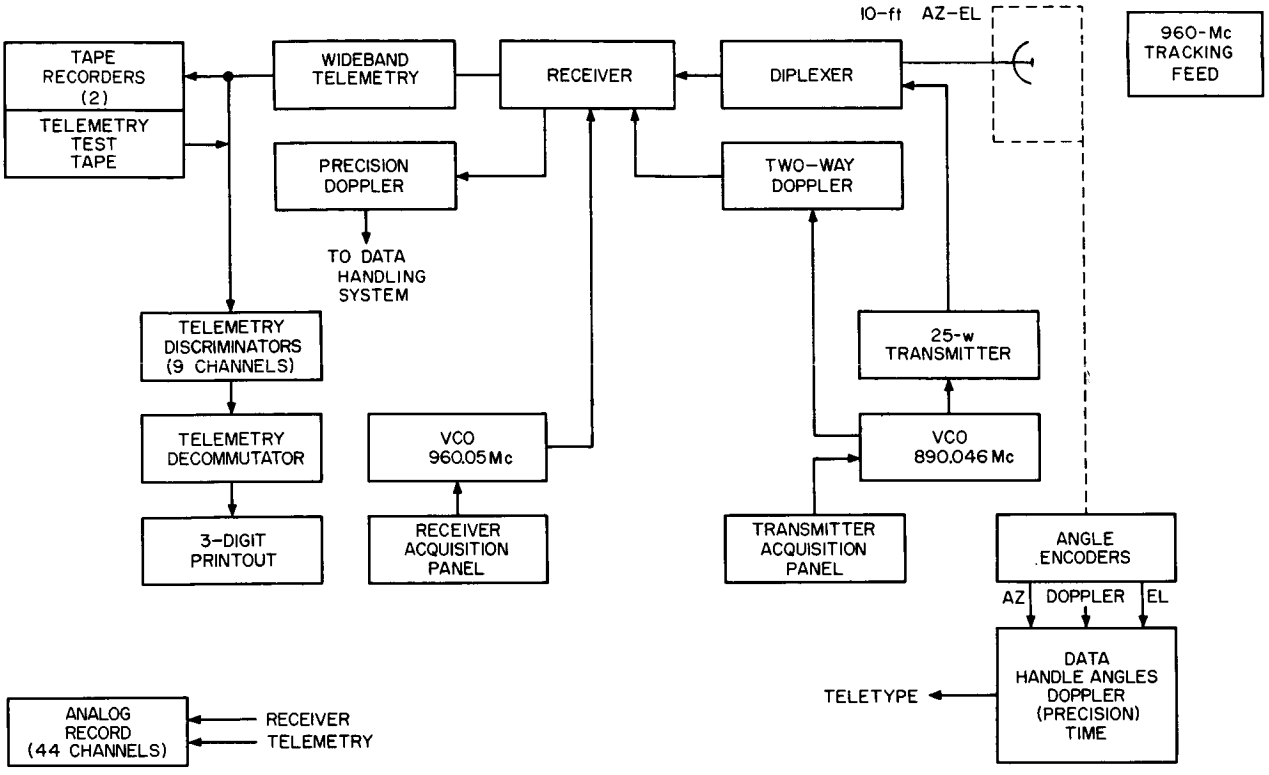


Fig. 31. Mobile Tracking Station equipment configuration for *Ranger 4*

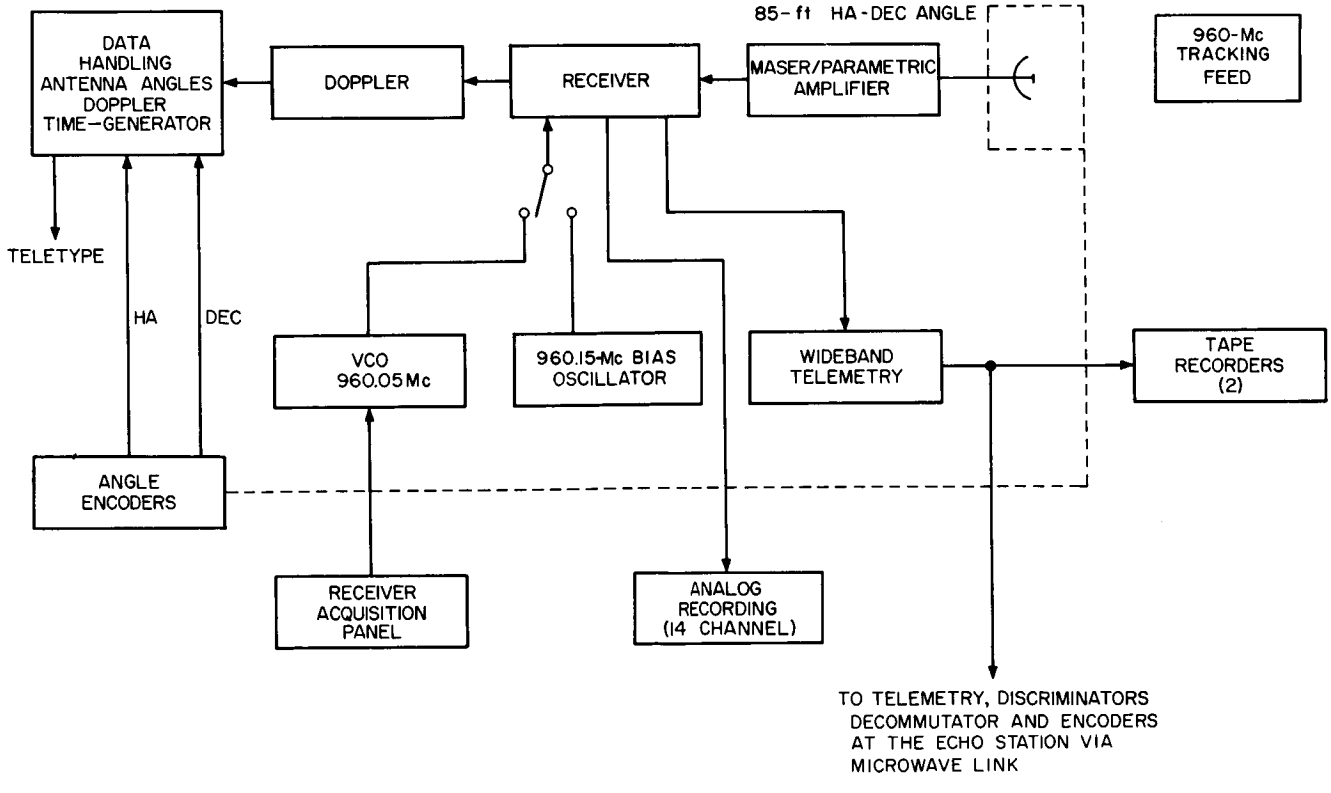


Fig. 32. Goldstone Pioneer Station equipment configuration for *Ranger 4*

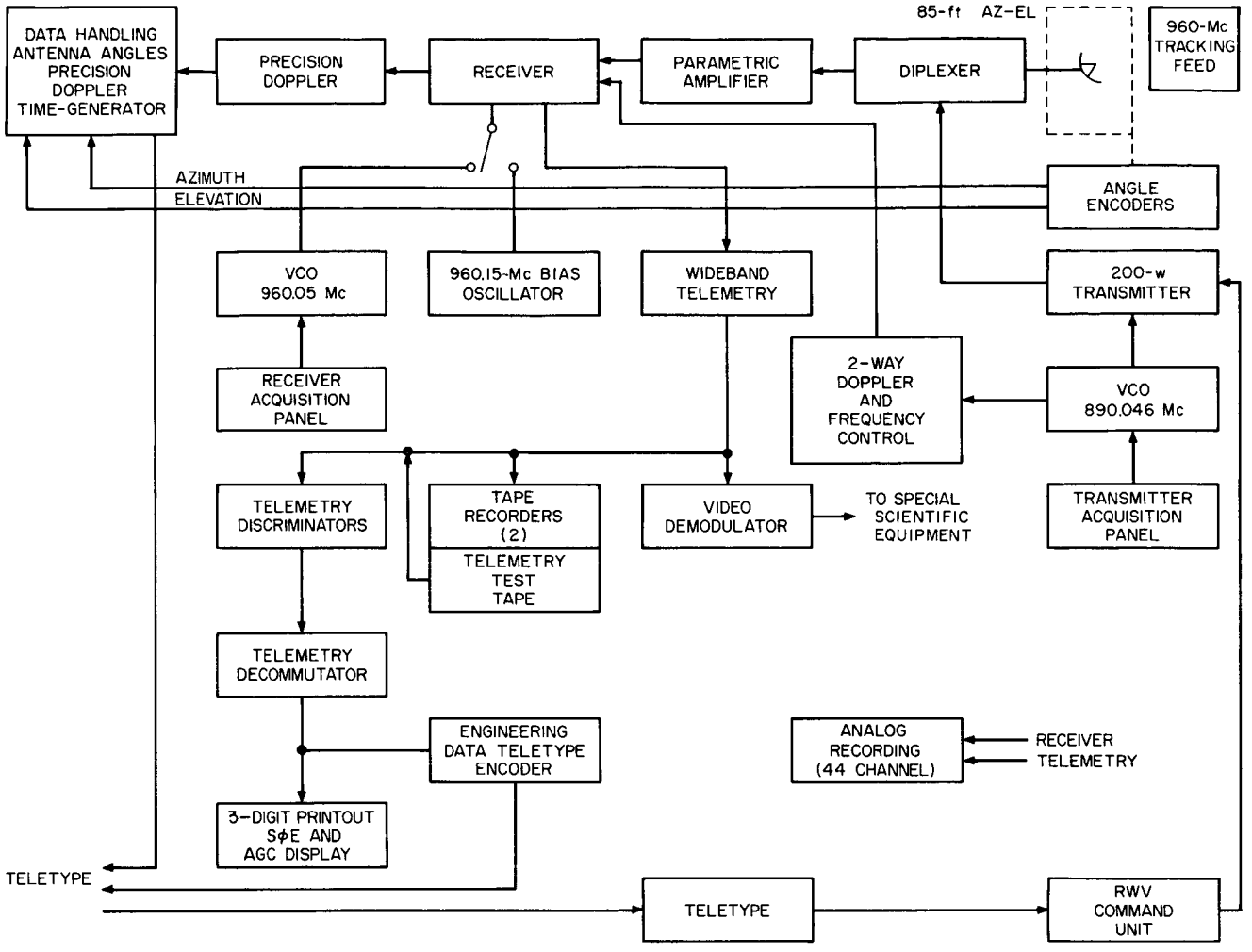


Fig. 33. Goldstone Echo Station equipment configuration for *Ranger 4*

D. DSIF Preparation for Mission

In early April the DSIF began checkout and preparation of the station subsystems, concurrent with preparation of the spacecraft itself (Fig. 37–39). The DSIF stations conducted star tracks and extensive boresight vs. polarization tests; routine maintenance; testing and installing of components; and cleaning, adjusting, and calibration of system equipment. Practice countdowns were conducted by all stations through mid-April and culminated in the simulation of spacecraft launch and tracking operations during the network integration tests of 16 and 20 April. All DSIF stations were "in the green" on 23 April.

The following paragraphs describe significant events occurring at each DSIF station during preparation for the *Ranger 4* mission.

1. Mobile Tracking Station

During the launch simulation exercises, only one problem was discovered. On 16 April radio system personnel had difficulty with the dynamic phase error: both 60 and 400 cps were present at the receiver output. A cable problem in rack 7 and a misplaced ground on the pseudo two-way switch installation were responsible.

2. Goldstone Pioneer Station

On 5 April a program was initiated to install new equipment, modify existing equipment, and thoroughly check the calibration and operation of the complete system. The system was checked out and made operational by 19 April. Optical boresights were made 18–20 April. A star track (Alpha-Virginis) was accomplished on 18 April. The star track data were teletyped to JPL

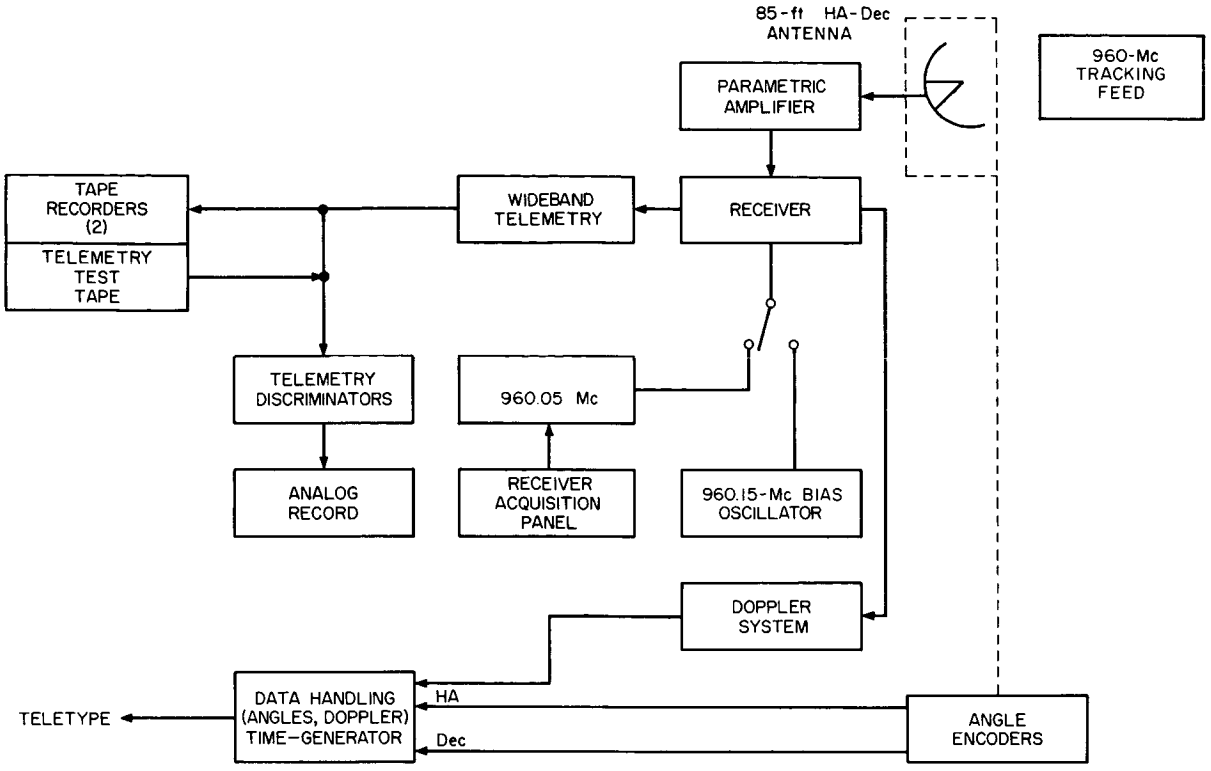


Fig. 34. Woomera Station equipment configuration for *Ranger 4*

for analysis on 18 April, and the results of the analysis were received on 19 April. An error existed in the angle readouts; however, JPL advised that it was not great enough to necessitate changes in the encoder alignment at that time.

3. Goldstone Echo Station

A transmitter failure occurred during the net integration test on 16 April at the Goldstone Echo Station (Fig. 40). Because a coolant over-temperature indication was observed, an overall maintenance check was made of all connections and associated circuits. No indication was found that could be related to the transmitter failure. After the transmitter was reenergized, the indication disappeared and did not reappear in any of the subsequent tests.

4. Woomera Station

A procedure which should provide better time correlation of camera exposures and simplify their data reduction was used for the first time during a star track on 10 April. A locally designed automatic camera frame coding system was used in which the state of the four camera code lamps, representing a binary number 0 to 15, is printed out in the data format.

5. Johannesburg Station

During the net integration test on 20 April, while commands were being sent, the transmitter tripped out. This fault could not be simulated again, but it is thought to have been due to a rectifier air interlock which apparently developed a resonance under certain conditions. The vane was replaced by a longer one and the fault did not recur.

Prior to launch the station performed one star track. Beta Corvi was tracked on 3 April; but due to the low magnitude of this star, camera pictures were not obtained. Although the results were accepted by JPL, an evaluation of this star track indicated that it did not agree with those carried out before the *Ranger 3* mission; therefore, two more star tracks were required. A track of Spica was completed on 13 April and one of Gienah on 15 April.

Spacecraft acquisition practice was delayed by the aircraft undergoing a major overhaul. On 16 April, at the first opportunity, the aircraft transponder was successfully acquired on the acquisition antenna at the first attempt, and a change to the main beam was made. Unfortunately, the aircraft had to return to base prematurely because of a generator malfunction.

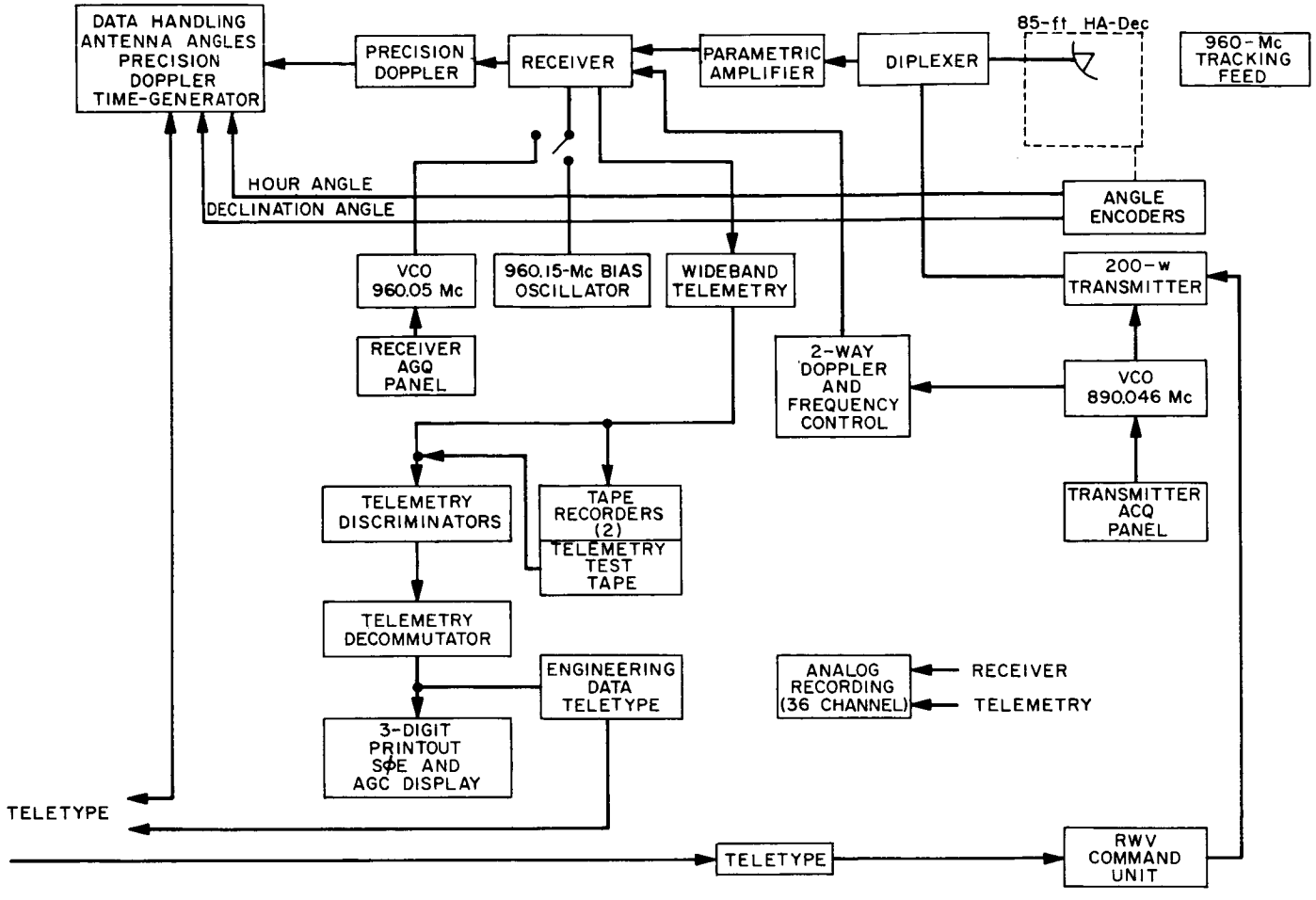


Fig. 35. Johannesburg Station equipment configuration for *Ranger 4*

A second practice was held on 18 April after a short countdown. During a 4-hr flight, acquisition was practiced and, in cooperation with the MTS, the transponder was locked up alternately by the two stations at will. It was not surprising to find that the more powerful transmitter at Johannesburg could "steal" the transponder when the MTS was in two-way lock. It was found necessary, for acquisition practice, to radiate from the transponder power monitor point in order to obtain a high enough signal strength for the acquisition antenna, but the "two-way" lock was practiced with the transponder radiating from the normal antenna jack. A third aircraft practice tentatively scheduled for 20 April was cancelled in view of the excellent results obtained 18 April.

E. Tracking Operations

The DSIF tracked *Ranger 4* continuously from shortly after injection until just before lunar impact (Ref. 2). The MTS detected the transponder signal (960.05 Mc) at 211312Z. Johannesburg first detected the signal at 211422Z. Fifteen minutes later the MTS accomplished two-way acquisition. As soon as successful lock was established, it became apparent that a major spacecraft failure had occurred. Except for channel 1 (the spacecraft frequency reference channel), all telemetry channels were in lock but no telemetry commutation was occurring. The received signal level was varying considerably. At 213428Z the MTS reported the signal level was −125 dbm with an 18-db variation occurring between 213330Z and 213510Z. Johannesburg reported at 2205Z that the received signal strength was −104 dbm with a variation of 14 dbm in a 4-min period.

No particular difficulty was experienced in tracking during this initial phase. Woomera successfully acquired the transponder signal at 23/2223Z and tracked the spacecraft for approximately 45 min. For 20 min during the early portion of its tracking period, the Woomera Station tracked the capsule signal. As in the case of the

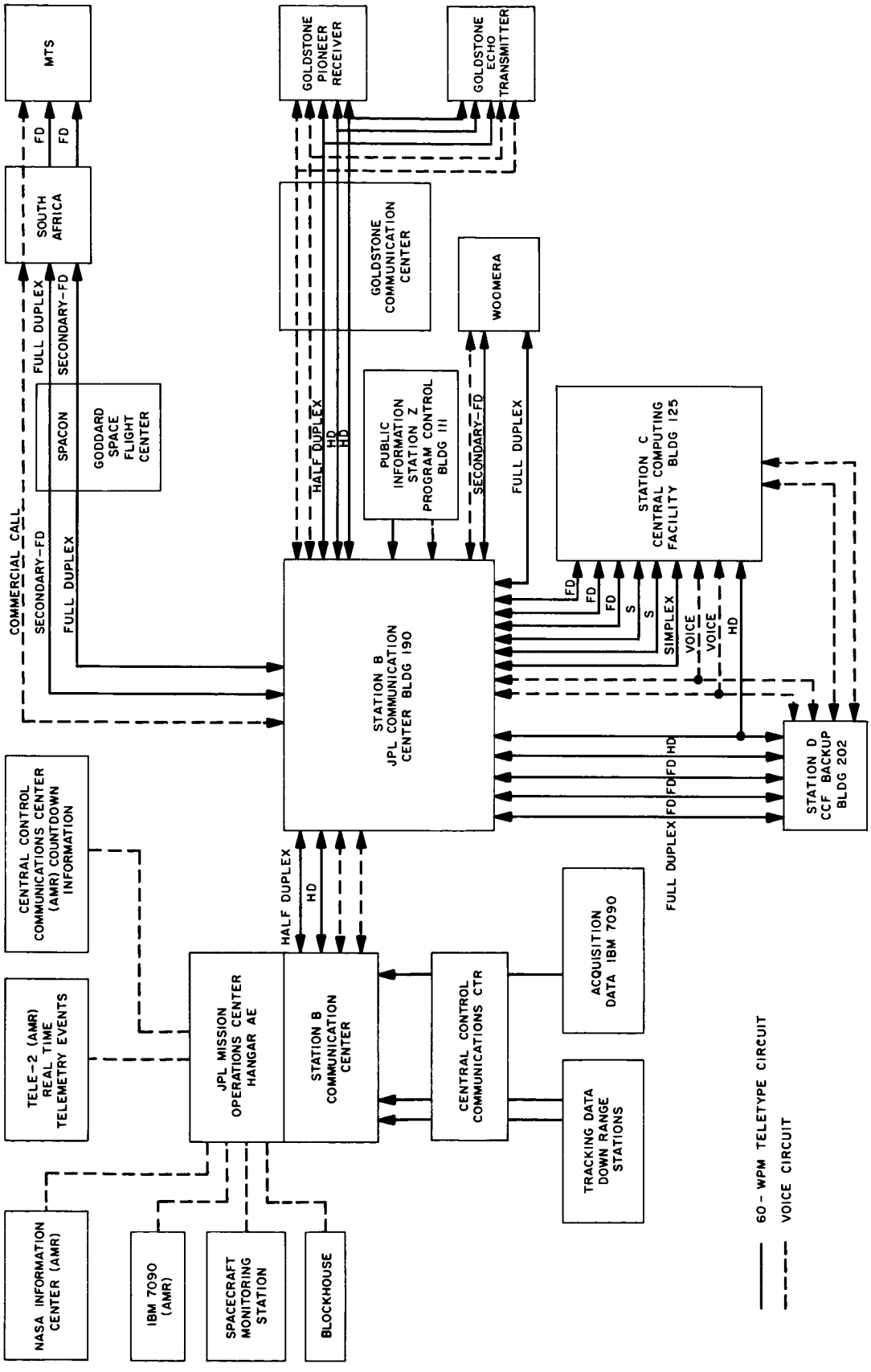


Fig. 36. Communications net for *Ranger 4*

Fig. 37. Omniantenna adjustment and installation in *Ranger 4* spacecraft

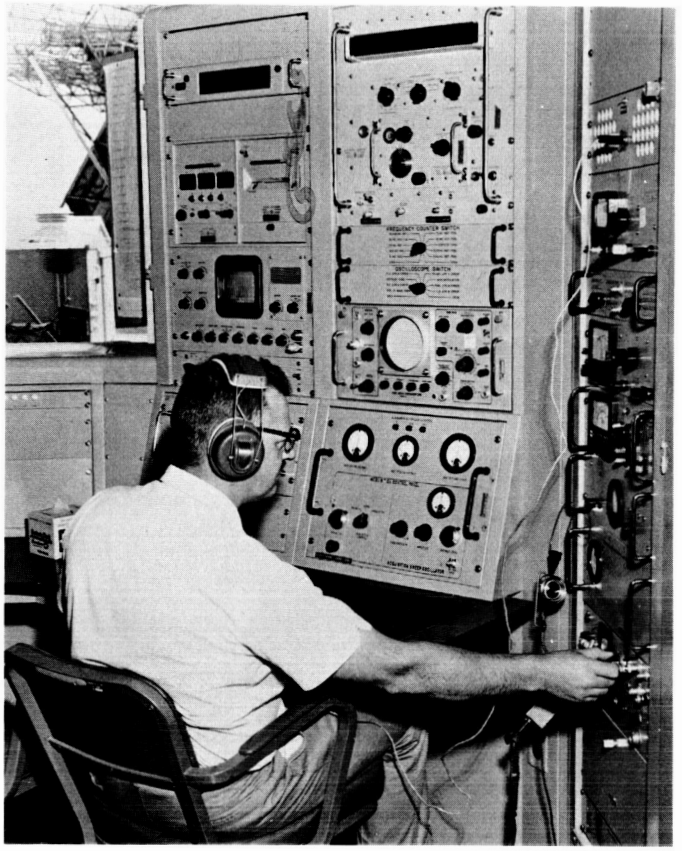


Fig. 38. Receiver checkout at Goldstone Echo Station

transponder signal, this signal was also varying. At 2215Z the received capsule signal strength was −152 dbm with a 5-db variation every 20 sec. Approximately every 4½ min, a larger signal variation would occur and go below the receiver threshold.

At 23/2305Z, Johannesburg turned its transmitter on and, after the MTS had turned its off, successfully acquired the spacecraft transponder in a two-way mode. Johannesburg tracked in this mode until 23/2336Z when its transmitter was turned off. The MTS then reacquired in two-way lock. Tracking continued in this manner until 24/000754Z when Johannesburg turned on its transmitter and again acquired the spacecraft in a two-way mode. This tracking mode was maintained until 24/0721Z when the spacecraft transponder power failed. This was the first operational use of the Johannesburg transmitter and satisfactory two-way doppler data were obtained.

After 24/000754Z, when Johannesburg was in two-way lock, various commands were transmitted. Unsuccessful attempts were made to advance the spacecraft telemetry mode, to switch the transponder signal from the omni-antenna to the high-gain antenna, to change the high-gain antenna hinge angle, and to override the spacecraft roll control system.

After the spacecraft transponder signal disappeared, the MTS continued searching for it, while Johannesburg began searching for the capsule signal. The MTS search was unsuccessful and after an hour the station secured from the *Ranger 4* mission. Johannesburg, however, acquired the capsule signal at 081430Z and tracked it, with intermittent out-of-lock periods, until 084320Z when the spacecraft set below the horizon.

After disappearance of the transponder signal, the DSIF stations continued to track the capsule signal. (See Table 11 for approximate tracking times.) Searches for the transponder signal were conducted at least once during each station's visibility period, but no signal was heard. The capsule signal level gradually decreased and the variation in level was sufficient to cause intermittent loss of receiver lock.

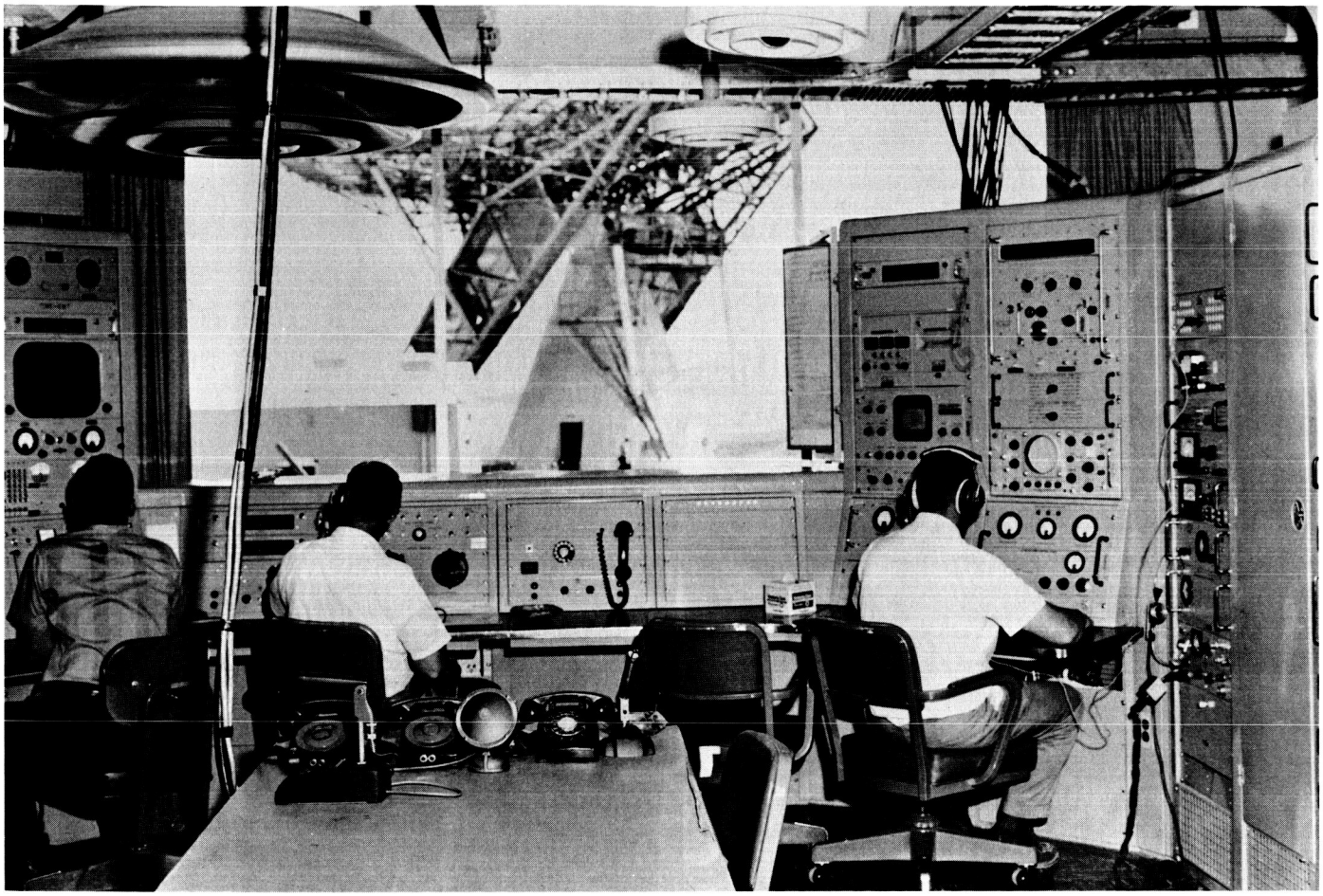


Fig. 39. Operational checkout at control center of Goldstone Echo Station

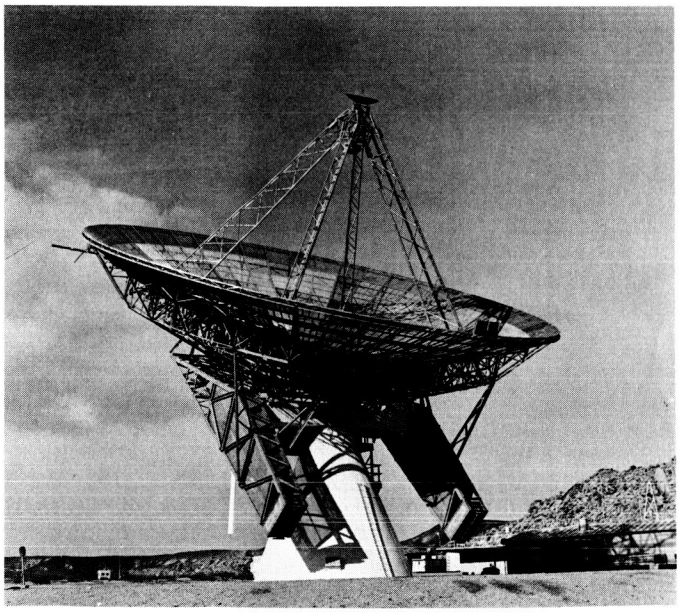


Fig. 40. Goldstone Echo Station's 85-ft Az-El antenna

Table 11. Approximate tracking times during *Ranger 4* mission

DSIF station	Visibility period (date/GMT)
Mobile Tracking	23/2113 to 24/0719
Johannesburg	23/2114 to 24/0843
Woomera	23/2223 to 24/0006
Goldstone Pioneer	24/0832 to 24/1703
Goldstone Echo	24/0904 to 24/1705
Woomera	24/1352 to 25/0159
Johannesburg	24/2122 to 25/0925
Goldstone Pioneer	25/0847 to 25/1730
Woomera	25/1423 to 26/0213
Johannesburg	25/2140 to 26/0932
Goldstone Pioneer	26/0846 to 26/1248
Goldstone Echo	26/0833 to 26/1248

Lunar impact was predicted for approximately 26/1250Z. During this final period both the Pioneer and Echo stations were able to track the capsule signal. The signal level was varying at both stations (from −150 dbm to threshold, −166 dbm, at Pioneer and from −153 dbm to threshold, −162 dbm at Echo) and receiver lock was being lost every 4 to 5 min. The Goldstone Echo Station continued to listen for capsule signals until 26/1350Z. Because no signals were detected, it was concluded that the spacecraft impacted the Moon. Tracking operations ceased.

Detailed accounts of tracking operations at each station are given in the following paragraphs.

1. Mobile Tracking Station

The signal was first observed on the horizon at 211300Z, and one-way acquisition was completed at 211312Z. Two-way acquisition was attempted after a consideration of the spacecraft trajectory, position at acquisition and advice from JPL. Some difficulty was experienced in acquiring two-way lock because of the following:

1. The poor condition of the audible telemetry modulation from the spacecraft was indicative of either an internal spacecraft problem or the receiver tracking a sideband. Therefore, a thorough search was made through the band in an attempt to determine the actual carrier.
2. The indication from Johannesburg of good telemetry after acquisition from that station led both advisors and operators to believe that either internal problems existed at the MTS or that the carrier had still not been acquired. Therefore, another thorough search for the carrier was made.
3. When the actual two-way condition was attempted, the acquisition detector indicated a two-way lock, but was actually 180 deg out of phase.

Finally, a two-way lock was effected at 212018Z on the assumption that the proper carrier frequency had been acquired and that the receiver and instrumentation sections were functioning properly.

At 214242Z, instrumentation still was unable to lock telemetry channel 1 and had reported the absence of commutation. At 215800Z, instrumentation completed patching 400 cps into the channel 1 discriminator in an attempt to eliminate the possibilities of a faulty discriminator. Instrumentation was functioning properly. A periodic signal level variation, indicative of spacecraft tumble, was reported from radio and continued throughout the track. No serious operational difficulties were encountered by any of the sections during the track, and the track continued until loss of signal at 072300Z. A search for the signal was conducted until 083500Z, when the station was secured.

2. Goldstone Pioneer Station

Although the Goldstone Pioneer Station was originally scheduled to track only during the prelunar-impact period, it actually tracked during each of its visibility periods.

The spacecraft capsule was acquired in one-way lock at 083240Z on 24 April while the spacecraft was still below the horizon, and the signal was weak and intermittent. Gradually improving, the signal strength fluctuated from −142 dbm to threshold.

At approximately 1000Z discussion with the Goldstone Echo Station revealed a difference of 38 cps between the receiver VCO frequencies at Pioneer and Echo stations. This discrepancy was attributed to the receivers being locked on opposite carrier sidebands. Later it was determined that receiver lock was possible at five frequencies, the carrier, and two sidebands. Since the first sideband was more powerful than the carrier and since the VCO would drift off frequency at low signal levels, the receiver would lose carrier lock and acquire a sideband.

At 1007Z the receiver was in lock on the carrier, and normal tracking followed with intermittent loss of lock as the spacecraft tumbled. At 155000Z it was determined that the precision doppler bias loop was out of lock, a condition that had existed since 142000Z. At this time a frequency log was initiated in which pertinent frequencies were recorded at 15- to 20-min intervals. Tracking was concluded at 1703Z.

On 25 April during the second tracking period, the servo system could not be operated in the slave mode due to computer operational difficulties. Aided track was employed throughout the second period. Acquisition of the capsule occurred at 084700Z. Three attempts to acquire the spacecraft transponder were unsuccessful. Maximum signal was observed by keeping ahead of the predicted look angles by 0.17 deg in HA and 0.10 deg in Dec. Signal levels generally were −151 to −157 dbm with variations from −142 to −42 dbm to the receiving

threshold. Tracking was terminated at 174820Z after an unsuccessful search for the transponder signal.

The third track on 26 April was accomplished with the servo system slaved to the computer. Acquisition occurred at 084600Z, and maximum signal strength was obtained by using offsets of the same magnitude as those used during the track on 25 April. At 090100Z and again at 092100Z the precision doppler bias loop dropped lock. A 50-ohm termination which was tied to the output of the Gertsch FM-6 31-Mc reference frequency source was removed and the center frequency of the loop was changed; the loop then retained lock for the remainder of the track. The operation continued until 124747Z when lock was lost as the spacecraft passed behind the Moon. Until 1330Z a search was conducted for the signal but none was detected. It was concluded that the spacecraft had impacted the Moon and the mission was terminated.

3. Goldstone Echo Station

At 090040Z the receiver acquired a one-way lock on the capsule signal with a strength of −141 dbm. The antenna was placed immediately in the slave mode. Signal strength varied from −141 to threshold due to spacecraft tumbling, and dropouts were occurring approximately every 4 min. For the entire view period the characteristics of the received capsule signal remained unchanged.

Except for two periods each of approximately ½-hr duration, when acquisition of the transponder signal was attempted, the capsule signal was tracked for the entire pass. Transponder acquisition was first attempted at approximately 1230Z, and the transmitter was switched on at 124640Z in an attempt at two-way lock without success. Capsule tracking was resumed at approximately 1305Z. The second transponder signal search was conducted from 1530Z to 1600Z. After this second unsuccessful search, capsule tracking was resumed and continued until the end of the visibility period at 170452Z.

Because of fluctuations in the received signal level some difficulty was experienced maintaining receiver tuning. During the periods when the signal was near receiver threshold, the receiver would lock on the upper sideband instead of the carrier. This sideband lock would occur when the signal level was increasing after having been out of lock. After locking on the sideband it would then be necessary to place the receiver in the acquisition mode and reacquire the carrier. Since this sideband lock caused an erroneous doppler readout, the receiver frequencies were constantly monitored.

Fluctuating signal levels also caused the capsule telemetry discriminator to lose lock. To remedy the condition, a 1% loop bandwidth selector was installed in place of the normal capsule filter in the channel 2 discriminator which allowed discriminator lock to be held despite fading signal conditions.

The Goldstone Echo Station did not again participate in the tracking mission until 25 April. Countdown for this tracking period began at 020000Z. The TV tests were again deleted from the countdown because of the operating conditions. The receiver locked on the capsule at 083300Z with a signal strength of −158 dbm. The servo system was in slave mode with offsets being used as required. Instrumentation used the telemetry signal from the Goldstone Pioneer Station because of better signal-noise conditions. Signal strength was averaging −155 dbm but varying ±5 db with dropouts still occurring approximately every 4 min. An approximate half-hour search for the transponder was begun at 0852Z but was unsuccessful and capsule tracking was resumed.

During the last part of the track the acquisition camera of the TV system was turned on in order to view the Moon. At 124754Z, the instant the leading edge of the Moon crossed the center cross-hair of the TV screen, the receiver reported an out-of-lock condition. The mission was concluded at 133100Z after a search was conducted to see if the signal would be reacquired at the opposite edge of the Moon. Since no signal was received, it was concluded lunar impact had occurred.

4. Woomera Station

Acquisition at Woomera occurred at 2222Z. The D2 column in the Central Computing Facility predictions was incorrectly interpreted as the pseudo two-way doppler mixer output between South Africa and Woomera instead of the South African two-way doppler mixer output. Considerable effort and time were expended in attempting to tune the receiver before the error was discovered. After the correct acquisition frequency was finally determined, the spacecraft was acquired well below the polar mask. After acquisition, the track proceeded in various modes until loss of receiver lock at 000600Z. No equipment failures occurred.

Second pass acquisition occurred at 135244Z on 24 April. Regular carrier dropouts continued due to spacecraft tumbling and low signal level. Three 30-min searches for the transponder were conducted but were unsuccessful and only the capsule signal was tracked. Because of the continual signal variation as the spacecraft tumbled and the very low signal strength (less than −148 dbm the majority of the time), it was difficult to determine whether the receiver was tracking the carrier or a sideband. Frequency predictions which may have resolved the problem were not available. Twenty-six minutes of cumulative doppler data were lost due to a patching error in the teletype format. Otherwise the pass was uneventful and as smooth as can be expected from a signal falling regularly below threshold. Tracking terminated at 015900Z.

Acquisition was made during the third pass at 142300Z on 25 April and the spacecraft was tracked but not necessarily the carrier frequency. Signal level dropouts were still experienced (about 13/hr). After an 11 hr and 50 min period of intermittent tracking, the mission was concluded at 0213Z on 26 April.

5. Johannesburg Station

After acquisition the receiver dropped lock at times, presumably due to the MTS attempting two-way lock on the transponder. Output frequencies on the telemetry channels remained substantially constant, and it appeared that the spacecraft commutator was faulty. Two periods of two-way lock were obtained. The first two-way lock was accomplished at 230747Z, and maintained until the transmitter was switched off at 233600Z. Two-way lock was reacquired at 000754Z on 24 April and maintained until the transponder signals ceased at 072150Z. During the latter part of this lock a number of commands were sent to the spacecraft, but they produced no discernible reaction. The capsule transmitter was acquired at 081136Z and tracked until 084320Z, when the antenna moved into the western limit.

The view period beginning on 24 April was devoted to tracking the capsule, because it was assumed that the transponder batteries were exhausted, and the solar panels were nonoperational.

During the third tracking period on 25 April signals varied from −147 dbm to threshold and only telemetry channel 2 was periodically in lock. Periodic searches were made for the transponder but without results. The station acquired the capsule at 214013Z and lost lock at 093208Z. Participation of the station in the *Ranger 4* mission was terminated at that time.

F. Performance Evaluation

The overall DSIF performance during the *Ranger 4* mission was satisfactory, although there were some problems. Initially, a lack of telemetered transponder information (AGC and static phase error) and a failure of the pilot tone oscillator at the MTS made confirmation of two-way lock difficult. Although the telemetry records indicate that the transponder was interrogated from 211339Z, except for short dropouts, the station was not sure of two-way lock until 212605Z. At the Goldstone Pioneer and Echo stations during the third lunar impact view period, a drift of the 30-Mc bias oscillator introduced error in the one-way doppler data for that critical period.

Brief discussions of the results of studies of the various types of data obtained are presented below.

1. Telemetry

As well as could be determined from the station recordings, station performance appeared to be normal. Prior to acquisition by the DSIF stations, there was a malfunction on board the spacecraft; and, consequently, there was no telemetry decommutation for the mission. During the transponder tracking period, no event blips or any other evidence of programmed commands were observed. The frequent change between "in-lock" and "out-of-lock" condition for the telemetry channels was a result of the low signal level aggravated by the spacecraft tumble.

2. AGC Signal Levels

Direct comparison of the *Ranger 3* and *Ranger 4* signal levels was not possible for two reasons. Switchover of the spacecraft transponder signal to the high-gain antenna did not occur, thus precluding any signal level comparison during the initial portion of the mission while the transponder was operating. At approximately 0721Z on 24 April, when the transponder battery supply was depleted, the transponder signal disappeared, and the stations began tracking the capsule signal.

Comparison of signal levels between stations shows discrepancies which can be accounted for by differences in station-to-station fixed losses and/or differences in

probe look angle. The low signal levels, in some cases below threshold 50% of the tracking time, were on numerous occasions responsible for stations locking on a sideband rather than on the carrier.

3. Systematic Errors

A study of the angle residuals from the various stations showed several characteristics of the tracking system and tracking conditions:

a. The first pass local hour angle residuals at the Pioneer Station provided one indication of spacecraft tumble.

b. An abrupt boresight shift in the first pass RF declination residuals at Pioneer Station occurred at roughly the time of local sunrise. This shift might be explained by thermal deflection of the feed-quadripod.

c. The hour angle and declination residuals at Woomera and Johannesburg show a large amount of scatter due to noise, which was probably due to the lower signal of the mission and to spacecraft tumble.

d. Correspondence of the gross shape of the *Ranger 3* and *Ranger 4* residual curves for Johannesburg prompted the combining of the *Ranger 4* preflight calibration coefficients with a third order curve fit to the *Ranger 3* residuals. These new coefficients describe both the optical and RF error. Application of these new coefficients in place of the preflight calibration coefficients reduced the maximum error in local hour angle by approximately 0.02 deg, thus indicating that the errors are repeatable, and ultimately it should be possible to remove them by calibration.

4. Doppler Data

One-Way Doppler. Since there is no reason to believe the spacecraft tumble rate changed as the spacecraft approached the Moon, a 44- to 48-min peak-to-peak periodicity in the doppler residuals at Pioneer Station during the third pass was probably caused by the excessive frequency drift of the 30-Mc bias oscillator at both Pioneer and Echo stations. For Pioneer Station, plots of oscillator frequency vs. time show that the oscillator was functioning normally for the first 5 hr of pass 1 but for the rest of the mission was out of specification and varying somewhat periodically. For the Echo Station, the frequency drift was within the one part in 10^6 per hr specification for the first pass but was out of tolerance for the third pass.

Pseudo Two-Way Doppler. Study of data from the MTS and the Johannesburg Station during a period when the MTS was transmitting demonstrated the 1:1 relationship between the VCO drift and the doppler residual.

Two-Way Doppler. The doppler residuals for the MTS and Johannesburg were investigated by constructing correlograms to determine whether the fluctuations were of a random nature. The waveform observable in the correlogram for the MTS doppler was caused by a truncation error in the doppler residuals. A sinusoidal waveform — a direct result of spacecraft tumble — appeared in the correlogram for Johannesburg but was damped by some unknown cause. The tracking system may have experienced a step change in signal level or noise level at the time the auto-correlation was started, or there may have been a step change in the system itself.

5. Equipment Problems

The following paragraphs summarize the equipment problems encountered at each DSIF station during the *Ranger 4* mission.

Mobile Tracking Station. During the mission countdown some equipment problems were encountered. The 25-w final amplifier in the transmitter was breaking into spurious modes and/or oscillations and was returned. The back-up Gertsch in the Data Section had a poor in-lock adjustment range, and attempts to adjust or repair it during the countdown did not alleviate the condition. The Midwestern Oscillograph Recorder failed due to transmission problems and a hold of 69 min was required to allow replacement with a spare model 621 from Johannesburg. The pen on the Sanborn Recorder broke twice during the tracking sequence and required approximately 5 min each time to replace. No further problems were noted.

Goldstone Pioneer Station. The discovery at 1550Z, durin the first tracking period, that the precision doppler bias loop had been out of lock since 1420Z was cause for keeping a frequency log. Pertinent frequencies were monitored and recorded at 15- to 20-min intervals. Data Section personnel were cautioned to monitor and report unusual doppler count changes as soon as they were observed.

During the second tracking period the servo system could not be operated in the slave mode due to computer operational difficulties. Aided track was employed throughout this period.

The third tracking period was successfully accomplished with the servo system slaved to the computer. The receiver precision doppler bias loop broke lock at 0901Z and again at 0921Z, and an investigation was initiated to determine the reason for the loop malfunction. Excessive loop residual jitter in the one-way mode led to the belief that a trouble existed in the Gertsch FM-6 oscillator which provides the 31-Mc reference in the one-way mode. Either phase jitter or low output from the Gertsch FM-6 could cause this trouble. To improve the situation: A 50-ohm termination that had been "teed" onto the Gertsch output was removed. This improved the output, but the residual jitter was still present. The center frequency of the precision doppler bias loop was then changed to reduce the loop static phase error. After these alterations the loop retained lock for the remainder of the track.

During tracking, the amplitude modulation (spin modulation) Hallamore dc amplifier tended to oscillate at the higher gain settings and when the receiver was out of lock. Prior to the last tracking period, notification was received that recording of spin modulation was no longer required.

During the last tracking period, the Ampex 600 tape reel did not take up properly because of a bent reel. The bent reel was replaced and satisfactory operation was restored.

The Acquisition Relay VCO developed a floating ground during calibration and was replaced. A broken ground wire in the Hallamore module case plug was found to be the cause of the trouble.

Goldstone Echo Station. During the first few hours of the final tracking period, the 30.656550-Mc reference oscillator drifted out of tolerance. This oscillator was tested after completion of the mission and failed at that time.

On the last day of the *Ranger 4* mission, a failure occurred in the CEC-5-123 Oscillograph transport drive system causing the paper speed to be erratic. No attempt was made to correct this condition because machine shutdown would have caused a loss of data.

The parametric amplifier gain was not constant with time, drifting approximately 2 db over a period of several hours. Also, the parametric amplifier running-time meter failed.

Woomera Station. During the course of the second pass the parametric amplifier gain rose from 22 to 30 db. This was associated with an increase of pump power from 42 to 48 divisions, which in turn may have been due to the lack of temperature control of the Klystron power supply in this particular (nonstandard) parametric amplifier. This rise in parametric amplifier gain also occurred during the third pass (gain changed from 22 to 25.5 db).

The Gertsch frequency synthesizers were found to be rather susceptible to loss of lock. They were watched closely during the mission and operated correctly. It was found that the use of the spare Hewlett-Packard counter to monitor the Gertsch output converted the output of the doppler mixer from a sine wave to a rounded triangular wave. This undesirable feature did not affect the accuracy of the doppler count, but the additional harmonics fed into the receiver system were not regarded as beneficial.

Johannesburg Station. Just after launch the transmitter output fell to zero, and a hasty readjustment of the times-six multiplier was required during the station's acquisition period. This was a hazardous process as the antenna was moving at high speed.

The hour angle error signal fed to the servo section was found, during the final countdown, to be low and below specification. Attempts made to correct this deficiency consisted of reducing the reference channel gain (without improvement) and increasing the servo system isolation amplifier gain. The 890-Mc filter in the hour angle error channel was suspected of being the basic cause of this trouble.

During the final countdown it was found that the west hour angle clutch was sticky, and, consequently, it was cleaned.

After some hours of tracking, the declination low speed motor stopped "breaking away" at normal valve currents, resulting in the antenna remaining stationary until the valve current reached its maximum. This caused some deterioration in tracking accuracy.

G. *Participation of Non-DSIF Agencies*

1. Space Flight Operations Center

All orbit computations were completed approximately on time except the first which was to provide pointing data for the DSIF; however, the MTS acquired the spacecraft before receiving preliminary orbit predictions.

The inability to command the spacecraft changed the planned methods of formulating commands. Eighteen commands were sent in an attempt to obtain a response from the spacecraft. Since the situation did not require that these commands be transmitted in accordance with normal procedures, they were transmitted from SFOC (Fig. 41) to DSIF Control by voice. The spacecraft did not respond to any of the commands.

2. Spacecraft Data Analysis Team

Because of the failure of spacecraft communication, the mode of operation of the Spacecraft Data Analysis Team was changed. They had planned to monitor large quantities of data from the spacecraft. Instead, the analysis team had to identify the spacecraft failure using the small amount of data acquired prior to injection.

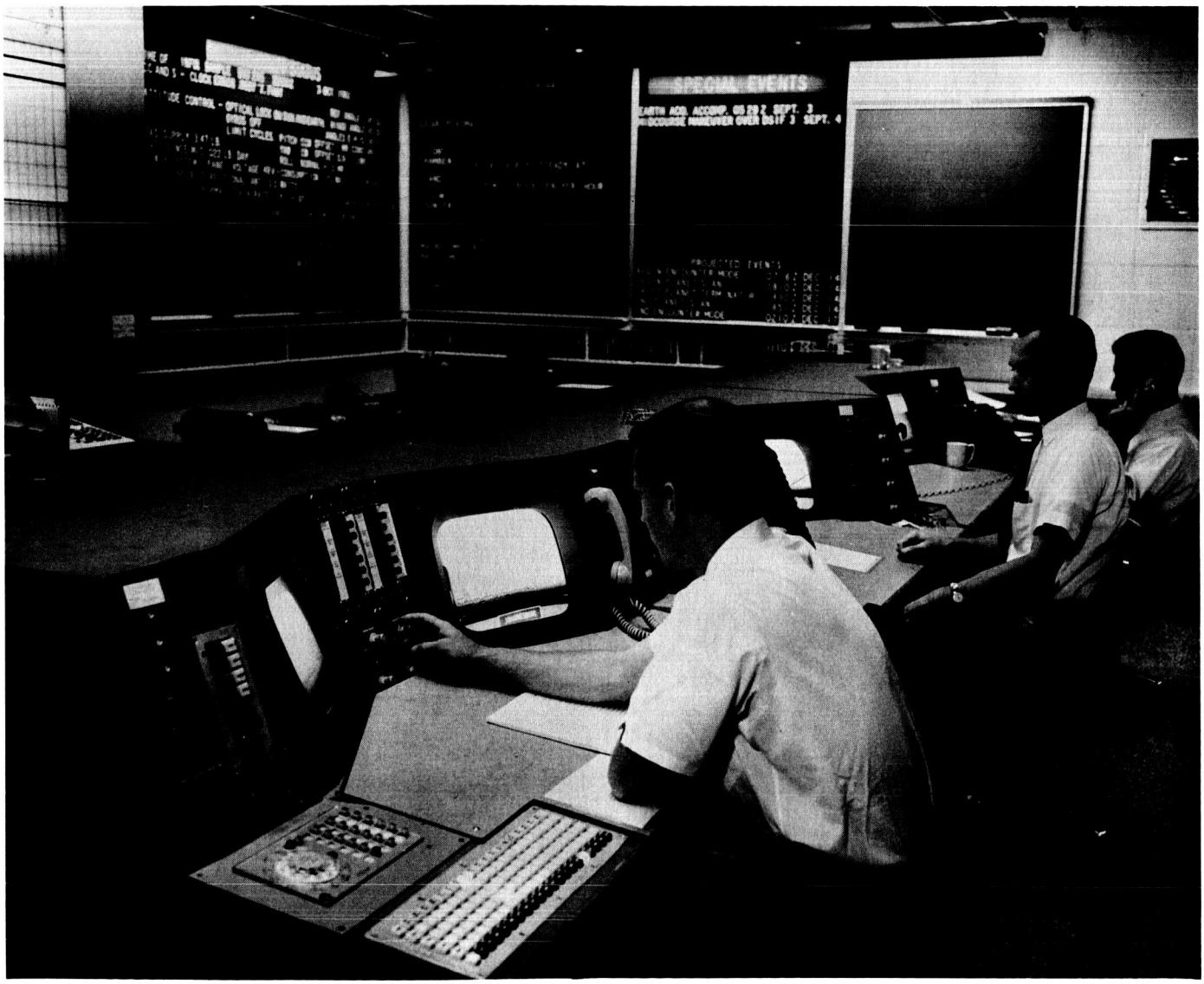


Fig. 41. Space Flight Operations Center communications monitoring consoles

3. Atlantic Missile Range

The AMR was assigned the responsibility of providing JPL with:

1. Orbital elements of the parking and transfer orbits.
2. Acquisition information for the MTS, Woomera, and Johannesburg.
3. Raw data for use by JPL to provide a backup to the computation of the transfer orbit. AMR instrumentation performed satisfactorily, with all stations (except Puerto Rico) acquiring the spacecraft normally.

Uprange Stations. Good data were received from the uprange stations with the exception of Puerto Rico. A network failure caused the data loss at Puerto Rico. The data from the TFV ship was sent to JPL in near-real time and was used to supply quick-look angles to Woomera and Johannesburg. The AMR had some difficulty in processing the TFV data; and, for this reason, the first orbit computation was performed by JPL.

Downrange (Ascension) Station. In general, the data received from Ascension were good. Ascension radar acquired the *Agena* C-band beacon at L + 1218 sec, continuing to track (with a 65-sec interruption) until the *Agena* set below the horizon at L + 3355 sec. The data from Ascension, sent to JPL in real time, went through six recycles to remove range ambiguities. These data were used to determine the *Agena* orbit and confirmed that the *Agena* would miss the Moon. The DSIF-calculated values of residuals showed that the range determined from the Ascension data was off +5.5 km and the elevation was high by 0.45 deg.

Twin Falls Victory Ship. The TFV ship acquired full automatic track at L + 780.55 sec. The range at the time of acquisition was 703 nmi and the azimuth was 288°48.2′. Minimum tracking range from the TFV ship was 182 nmi, with a maximum antenna elevation of 43°1.3′. The TFV ship lost signal at L + 1080.55 sec at a range of 993 nmi.

VI. *RANGER 5* MISSION

A. Flight Plan

The *Ranger 5* mission was the third flight aimed at lunar impact and had the same objectives as *Ranger* missions 3 and 4, which were:

a. Scientific experiments
   (1) To obtain photographs of the surface of the Moon.
   (2) To collect gamma ray data both in flight and at the vicinity of the Moon.
   (3) To receive lunar seismic data from the hard-landed capsule.

b. Engineering experiments
   (1) To experiment with a trajectory error correction (midcourse maneuver).
   (2) To experiment with a terminal maneuver.
   (3) To further the development of basic spacecraft technology through performance evaluation of the *Ranger* spacecraft.

The *Ranger 5* spacecraft was a duplicate of *Ranger 3* and *4* and included among its scientific instrumentation a gamma ray experiment, a lunar seismometer, and a vidicon. The scientific and engineering experiments aboard *Ranger 5* were the same as those used in *Ranger 3* and *4* (Table 9).

Ranger 5 also had midcourse and terminal maneuver capabilities (Fig. 42 and 43) and a lunar hard-landing capsule. In all other respects as well, the flight plan for *Ranger 5* was the same as that for *Ranger 4*.

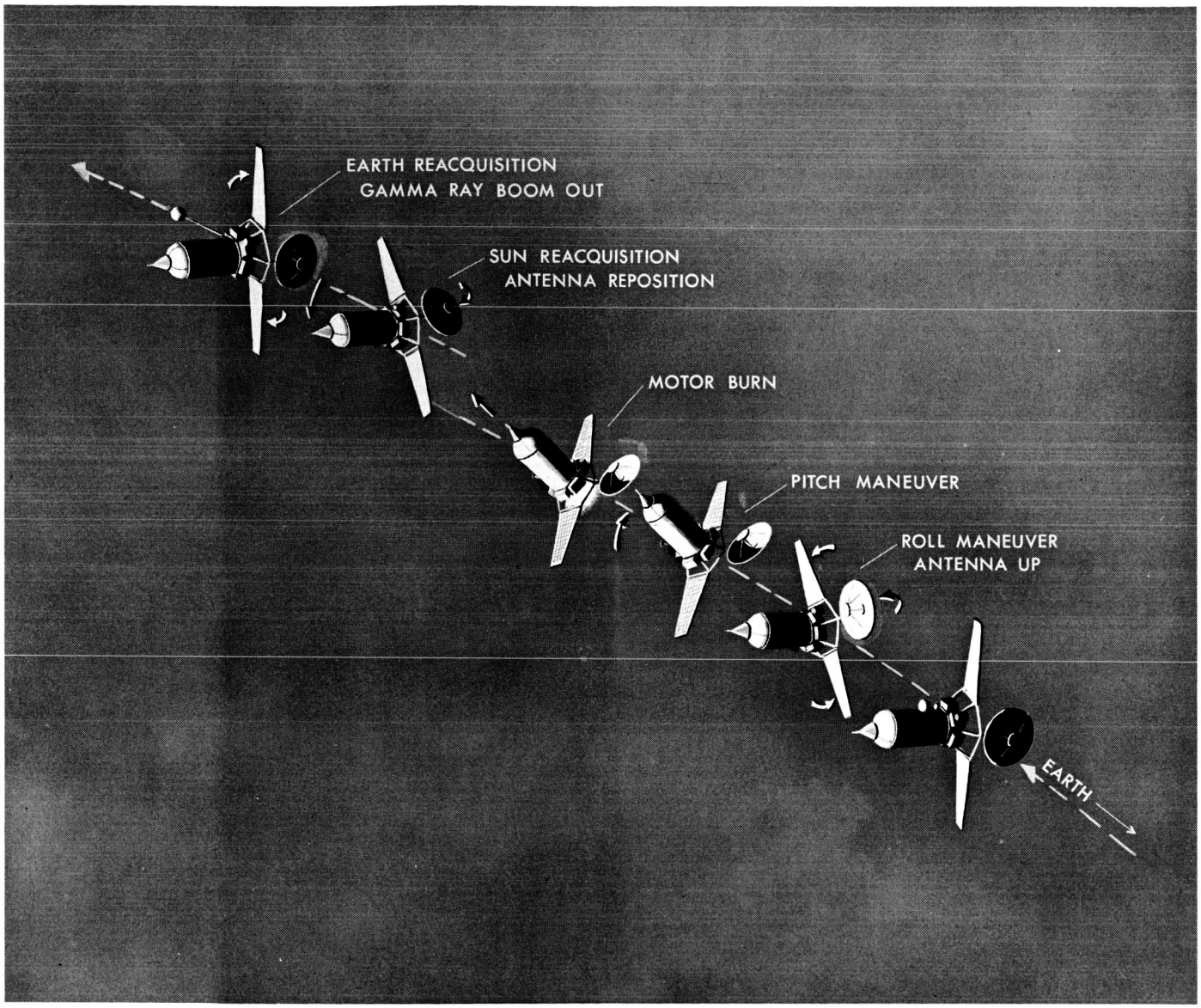


Fig. 42. Planned midcourse maneuver for *Ranger 5*

B. Mission Synopsis

Ranger 5 was launched by an *Atlas–Agena B* vehicle from Cape Canaveral on 18 October 1962 at 165907.8Z. The spacecraft performed properly during the launch, and data were received by the SMS until loss of lock at L + 458 sec. The boost phase of the launch appeared normal with the *Atlas* booster functioning as programmed. The *Agena B* performed properly throughout its flight. All preinjection events occurred at near nominal times. The spacecraft was successfully launched into its lunar intercept trajectory, with injection occurring at launch + 2140.24 sec.

Because of its trajectory, the spacecraft was not again tracked by the DSIF until 173028Z when it was acquired by the MTS in two-way lock. Next to acquire was Johannesburg with intermittent one-way lock. Continuous surveillance of the spacecraft by the DSIF began when Woomera acquired an RF lock on the spacecraft at 174539Z on 18 October. Subsequent surveillance periods are summarized in the appendix.

Approximately one-half hour after Woomera first acquired the spacecraft, JPL's Spacecraft Data Analysis Team determined from the telemetry that the spacecraft

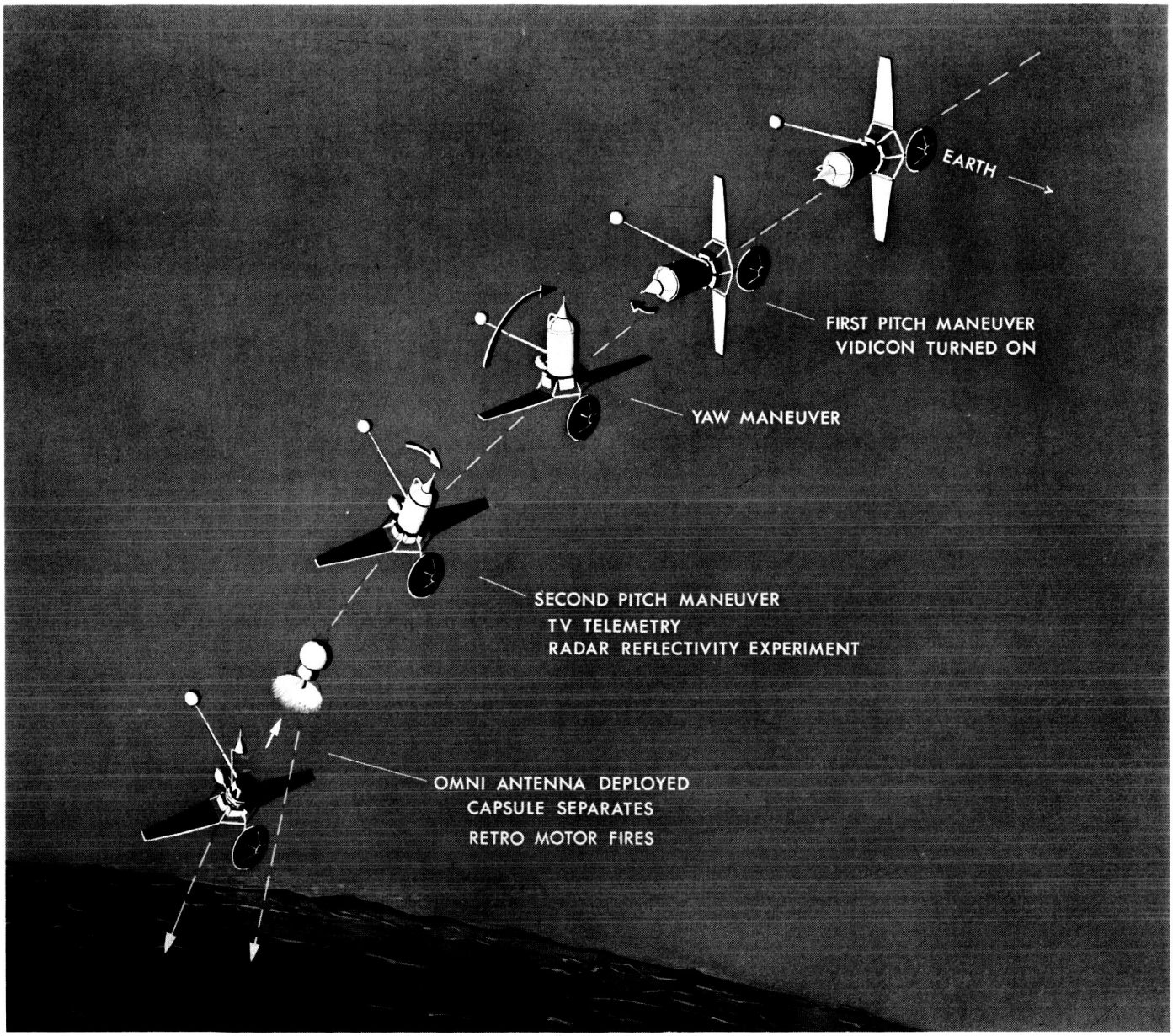


Fig. 43. Planned terminal maneuver for *Ranger 5*

solar panels were open, but that power from the panels was low. Since the battery had a limited life, they recommended that the midcourse maneuver be attempted ahead of schedule. The commands were sent to the spacecraft, but the maneuver could not be completed due to exhaustion of the battery power.

After the attempted midcourse maneuver, the DSIF continued to track the transponder signal with periodic success. The DSIF also tracked the *Ranger* 5 capsule transmitter signal until, on 21 October, the spacecraft was occulted by the Moon. When the spacecraft reappeared from behind the Moon, the capsule beacon was again tracked by Goldstone and Woomera.

Since the attempted midcourse correction was unsuccessful, the spacecraft trajectory carried it past the west or trailing edge of the Moon, 8 deg below the lunar equator. The closest point of approach occurred at 2000Z on 19 October 70.9 hr after liftoff. The altitude above the lunar surface at that point was 450 nmi and lunar referenced velocity was 2.3000 km/sec.

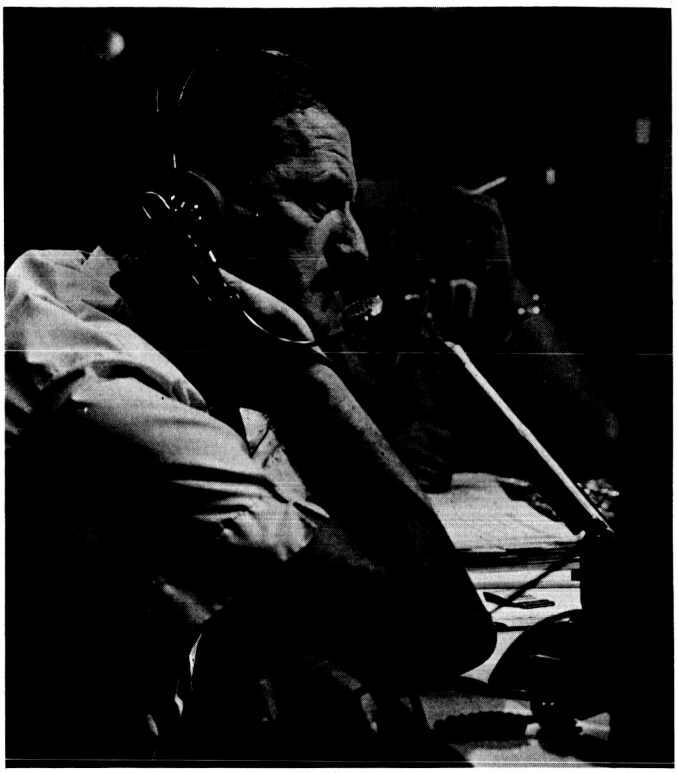


Fig. 44. Last signals heard as *Ranger 5* goes into heliocentric orbit

Following occultation on 21 October the DSIF began decreasing coverage. By 29 October the capsule signal level had fallen to −169 dbm at the Goldstone Pioneer Station and, as expected, on 30 October the capsule signal disappeared (Fig. 44). The DSIF secured from tracking *Ranger 5* on that date. The spacecraft was in a heliocentric orbit with a period of 366 days.

C. DSIF Configuration

Equipment configurations for the DSIF stations are shown in Fig. 45–50. The communications net for the *Ranger 5* mission is illustrated in Fig. 51.

D. DSIF Preparation for Mission

Preparation of the DSIF for the *Ranger 5* mission was carried out during a period of continuous tracking coverage of the *Mariner II* spacecraft. The necessity of integrating station preparation and checkout; equipment installation, checkout and familiarization; and net integration tests (Fig. 52) with the *Mariner II* tracking coverage made the completion of these elements of DSIF preparation more difficult.

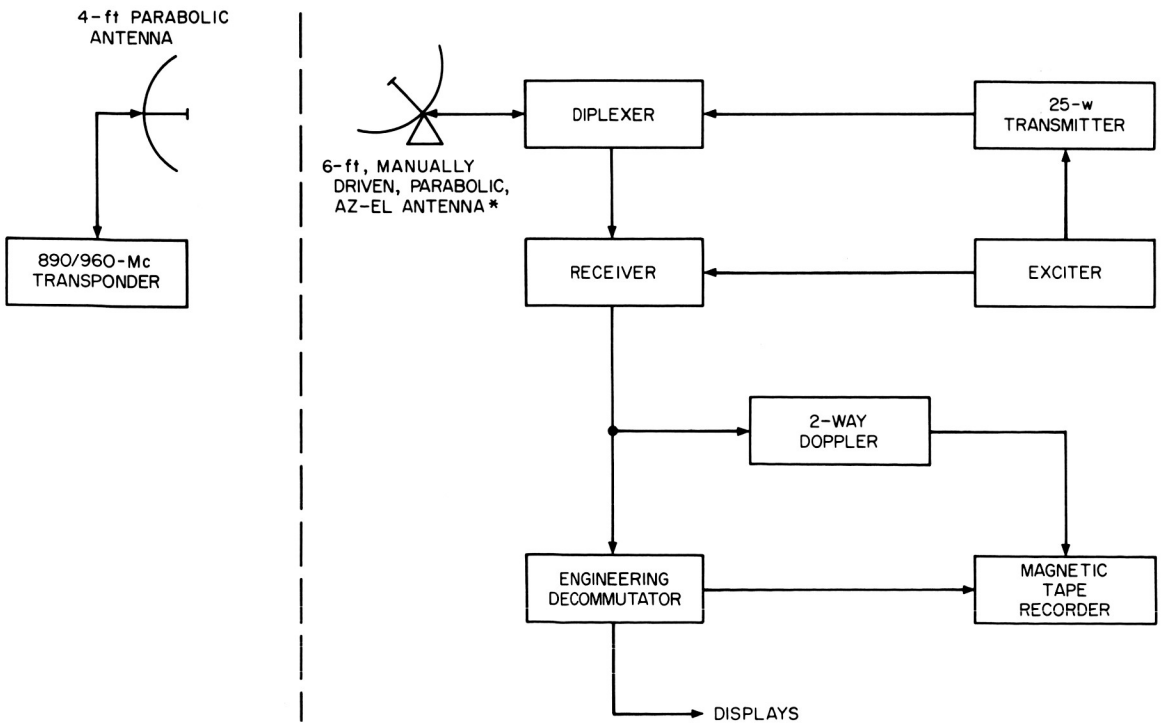


Fig. 45. Spacecraft Monitoring Station equipment configuration for *Ranger 5*

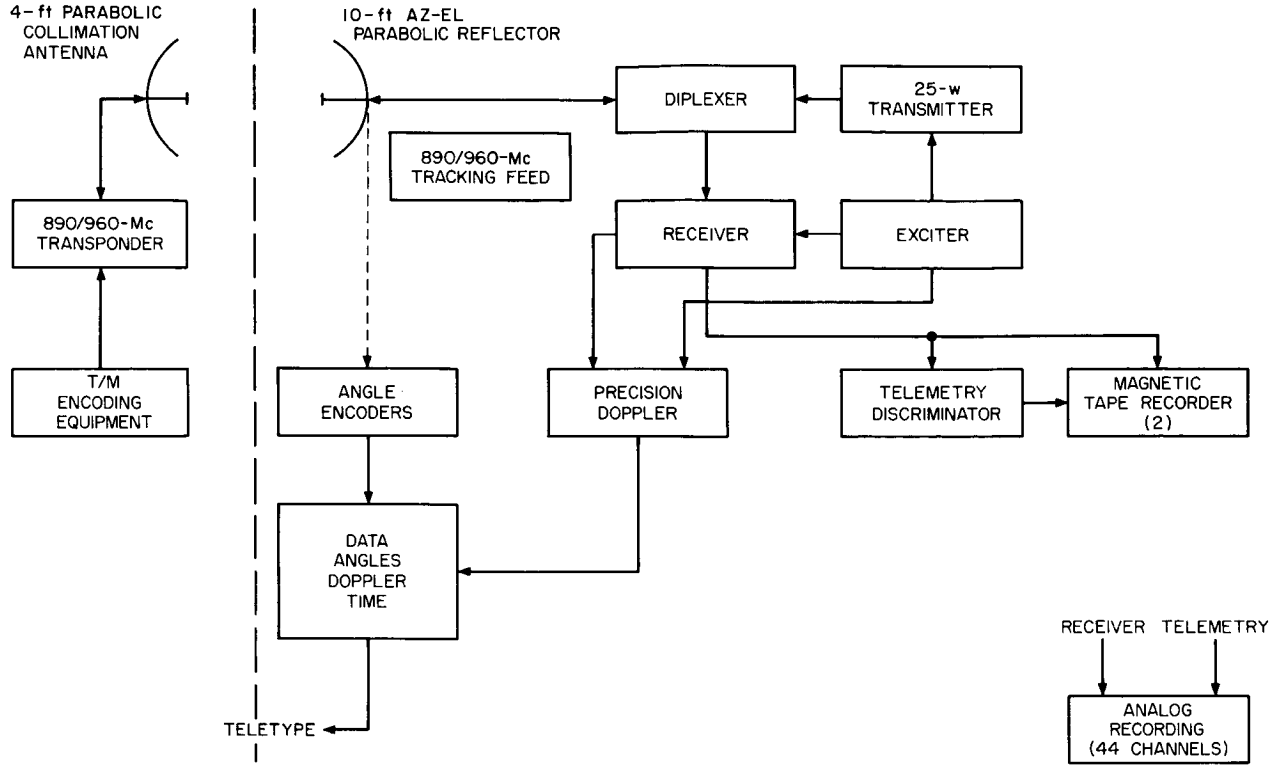


Fig. 46. Mobile Tracking Station equipment configuration for *Ranger 5*

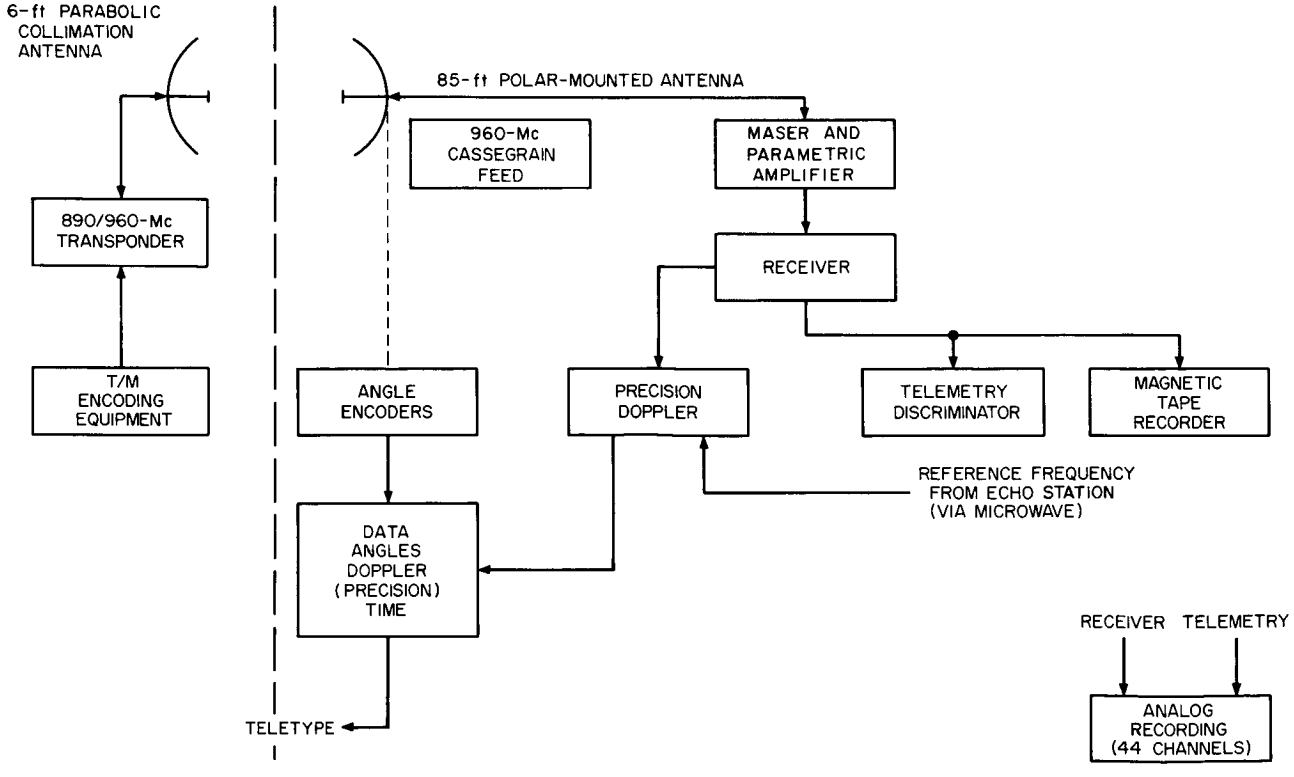


Fig. 47. Goldstone Pioneer Station equipment configuration for *Ranger 5*

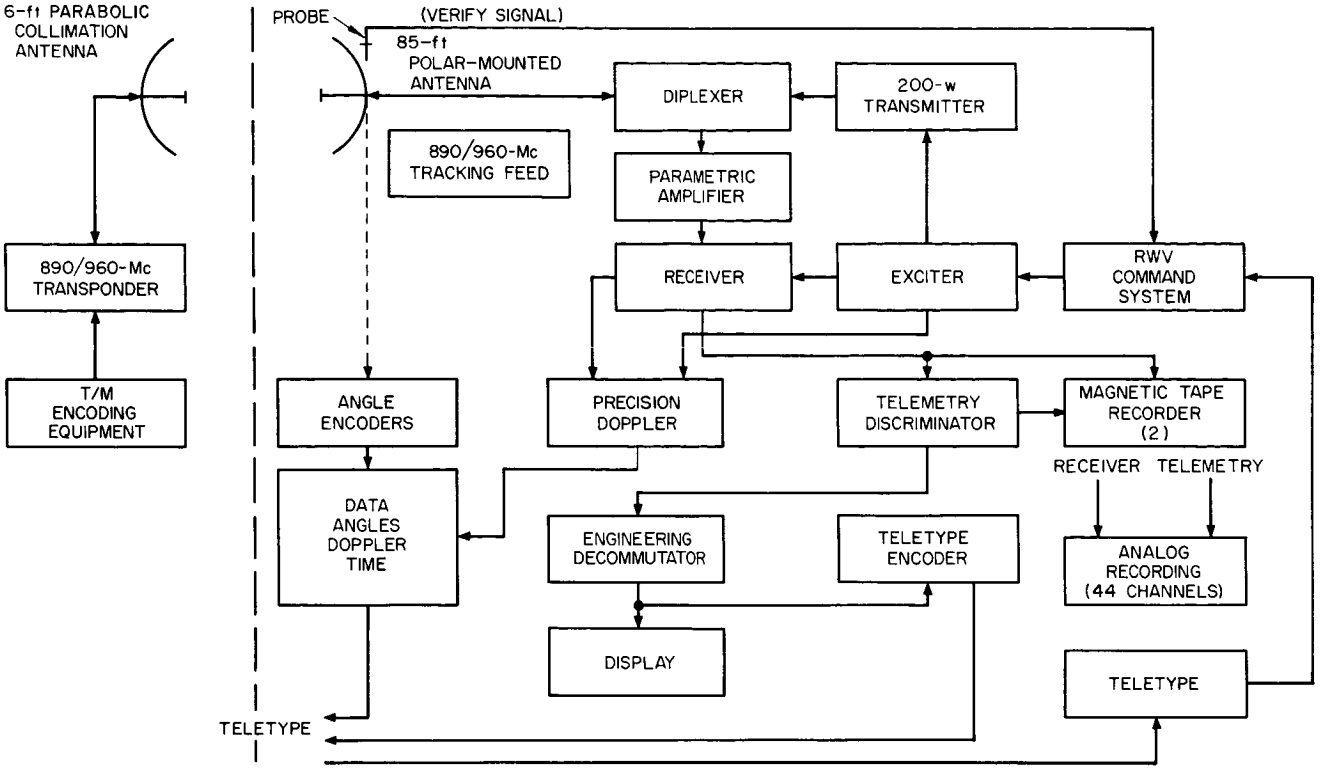


Fig. 48. Goldstone Echo Station equipment configuration for *Ranger 5*

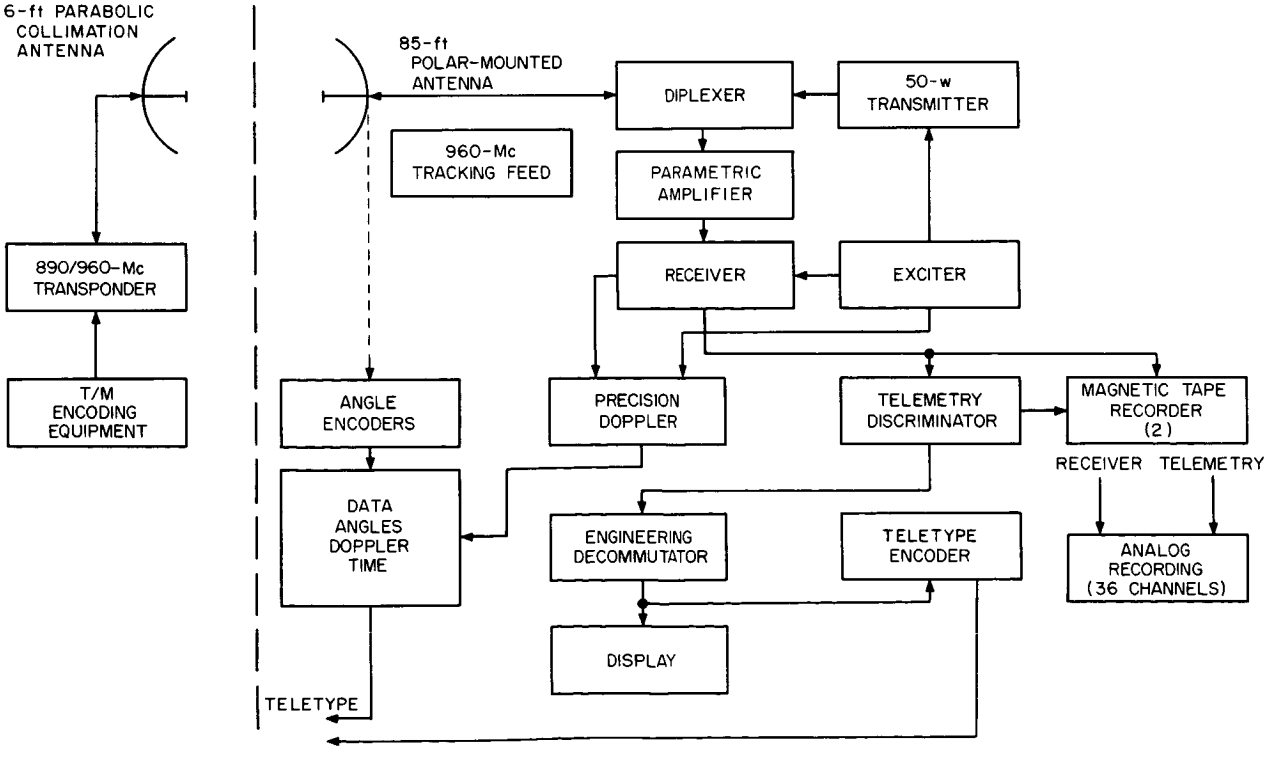


Fig. 49. Woomera Station equipment configuration for *Ranger 5*

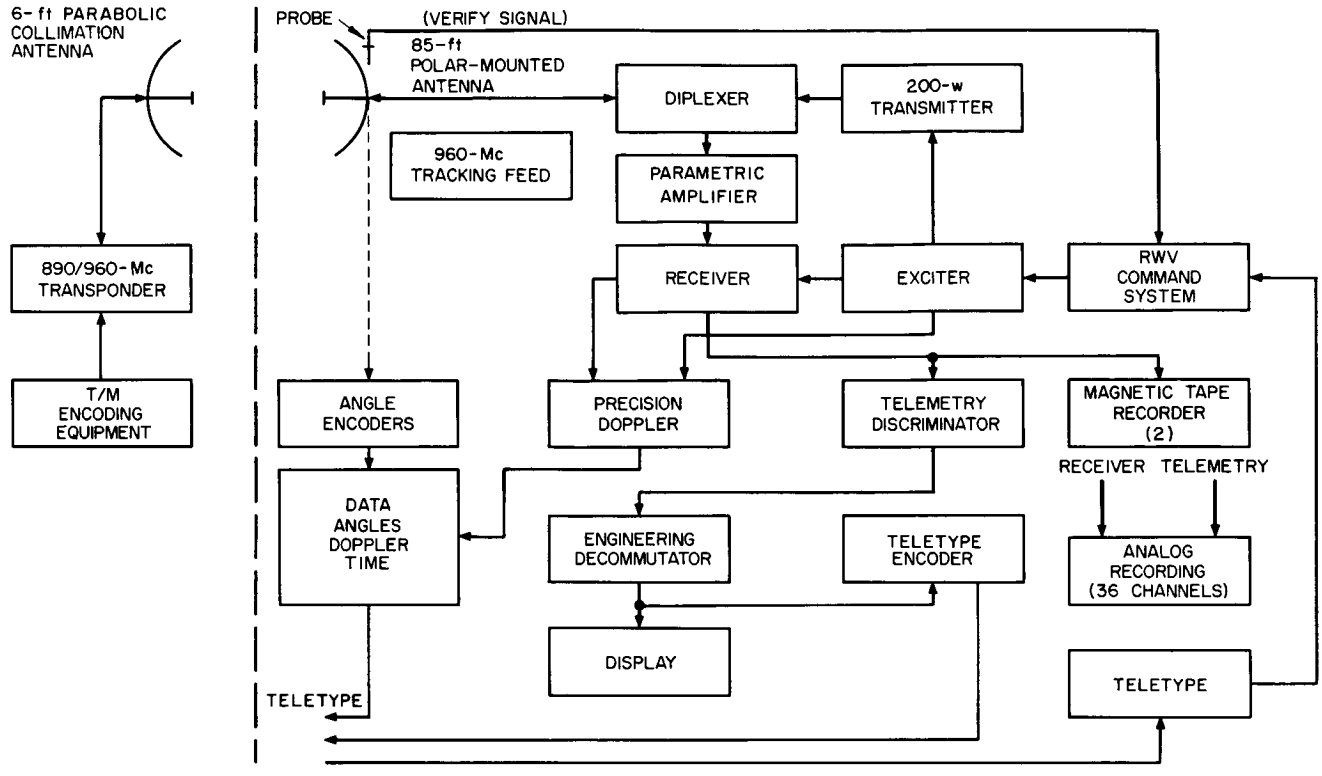


Fig. 50. Johannesburg Station equipment configuration for *Ranger 5*

1. Spacecraft Monitoring Station

Ranger emergency command equipment, consisting of a data scanner and phase modulator, was installed prior to the mission. The station ran a complete calibration of all functions on 18 September and all equipment performed very well. The discriminator threshold check was −135 dbm.

The RF from the directional antenna was steady and proved to be at the correct signal level at the RF Van receiver. The RF from the omnisystem still varied approximately 3 to 5 db.

The station participated in the DSIF net integration test on 10 October. No problems were experienced during the test except for the delay of the TWX messages to JPL because of congested TWX lines from hangar AE.

2. Mobile Tracking Station

Preparatory operations for *Ranger 5* began approximately 1 October. No new equipment was installed for the mission. Except for two net integration tests, the majority of the station preparation efforts consisted of internal checks by each section.

For the operational readiness test on 10 October the station conducted a full countdown prior to the simulated launch. During the countdown the Data Section experienced trouble with the Gertsch frequency generator, but other than this the station checkout was very smooth.

For the operational readiness test of 13 October the station again conducted a full countdown. During this countdown the transmitter power level was below normal and could not be corrected during the countdown. The next day the trouble was investigated and the problem solved.

Table 12 contains telemetry thresholds measured during the net integration tests and during *Ranger 5* countdown on 18 October.

3. Goldstone Pioneer Station

Prior to the launching of *Ranger 5*, the Pioneer Station was engaged in full-time tracking of the *Mariner II*

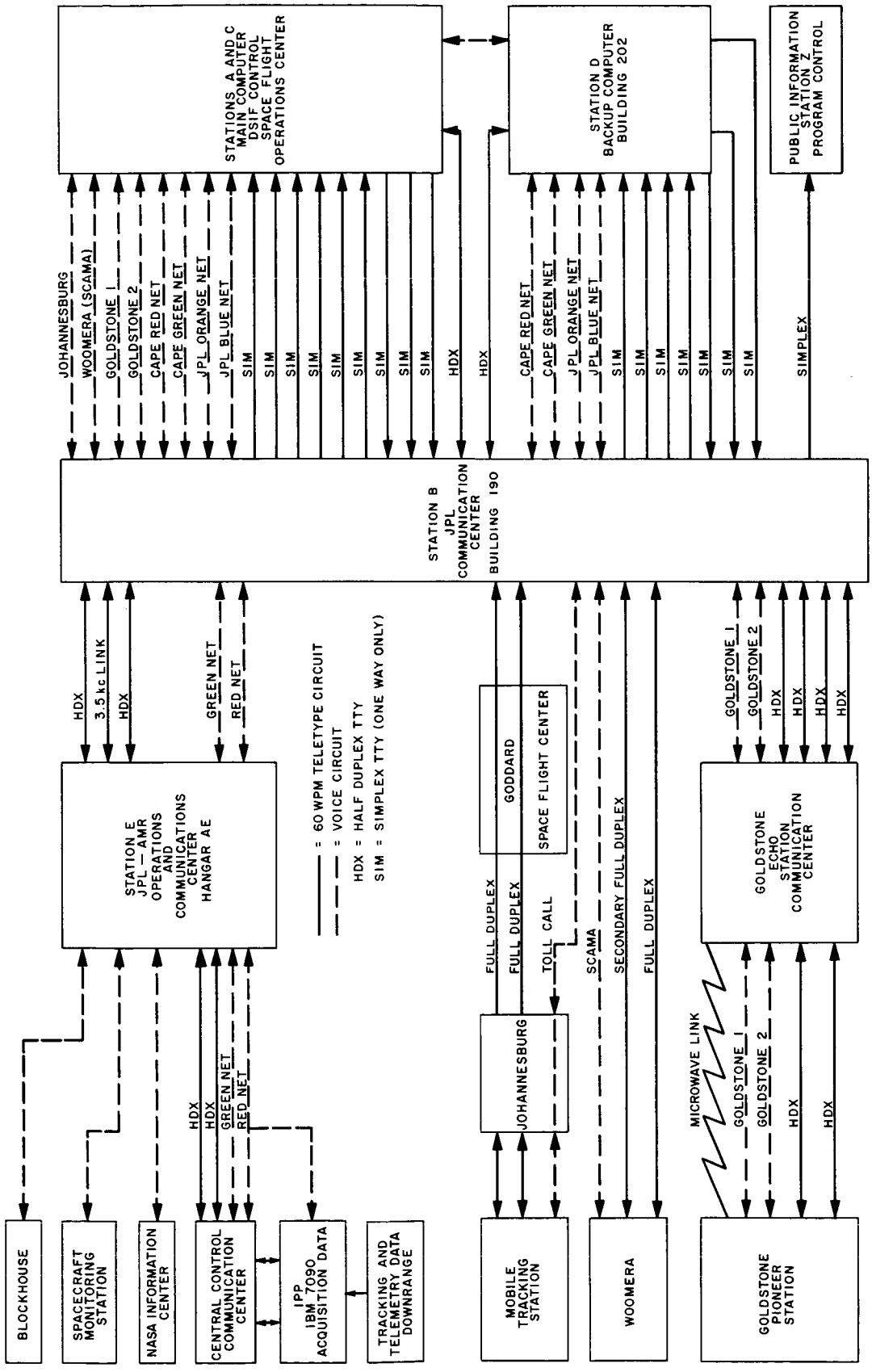


Fig. 51. Communications net for *Ranger* 5

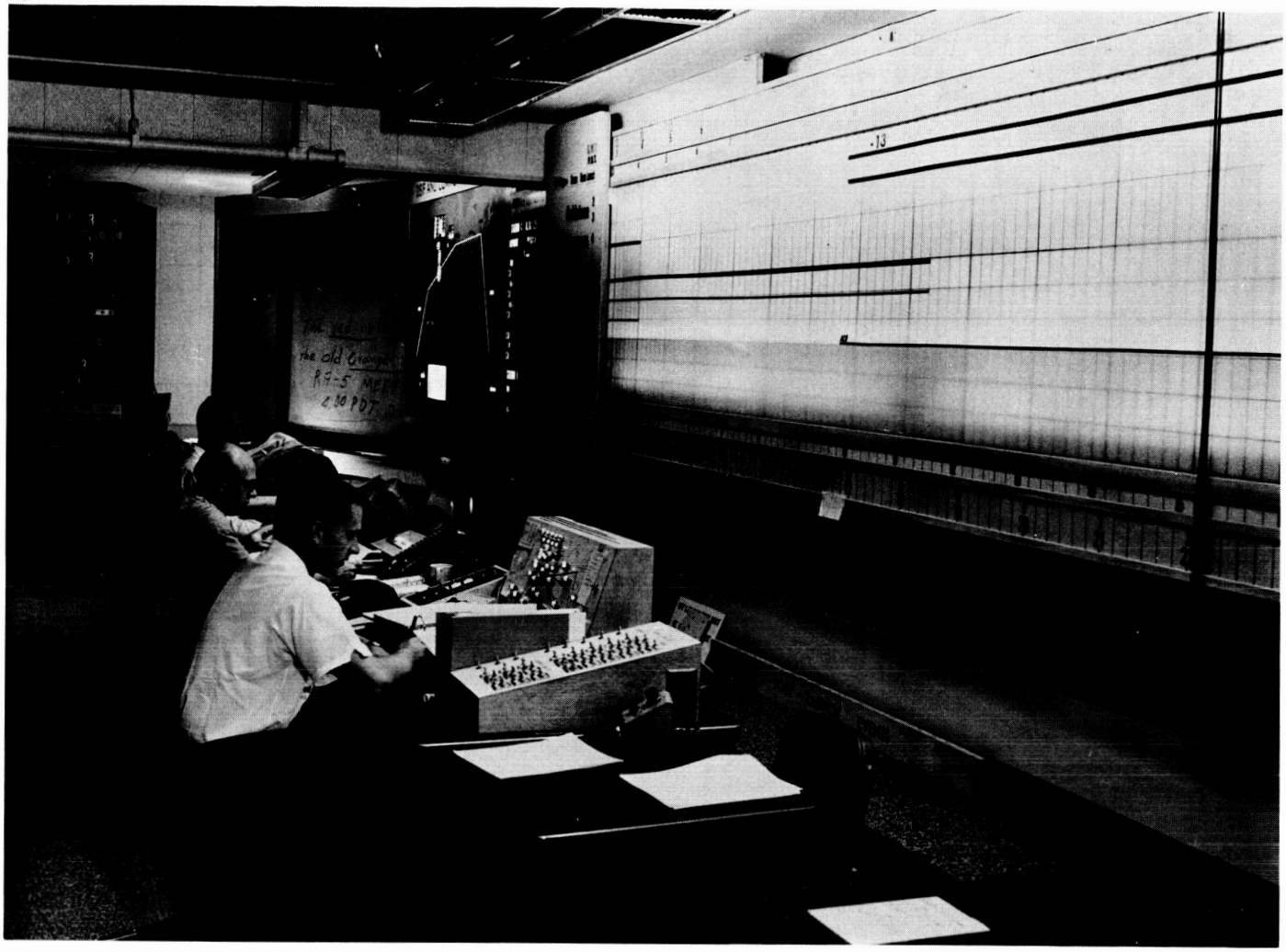


Fig. 52. Space Flight Operations Center during net integration test

spacecraft. Because of the *Mariner* assignment, no prelaunch operational tests were performed. The Pioneer Station did not participate in the two net integration tests and launch countdown operation; the station did participate in the communications tests.

Table 12. Telemetry thresholds for *Ranger 5* tests

Date, Oct	Channel signal level, dbm								
	1	2	3	4	5	6	B2	B19	B20
10	−144	−140	−142	−142	−132	−130	−142	−142	−138
13	−144	−138	−142	−142	−132	−130	−142	−146	−138
18	−142	−138	−142	−142	−132	−130	−142	−142	−138

Station personnel were organized into two operational crews. The first crew was designated to perform pretracking calibration checks, acquire the *Ranger 5* capsule, and operate the equipment during the early portion of each tracking period. The second crew was assigned to complete the tracking period, perform postcalibration checks, and gather all pertinent data for preparing individual station reports.

Prior to the first view period, station equipment was changed over to the *Ranger 5* configuration.

4. Goldstone Echo Station

In the two-week period prior to the launching of *Ranger 5*, station personnel were engaged in thorough checkout of all systems. Installation of new equipment,

a complete maintenance check, a star-tracking operation, and a series of prelaunch operational readiness tests were performed to insure that all systems were peaked for optimum performance. The Echo Station participated in a radio star-track mission on 3 October, and participated in countdown and net integration tests on 10 and 13 October.

A new *Ranger* 5 TTY Encoder Model 4-306A was installed to replace the old encoder; the new unit was more versatile. A two-way doppler system was installed in the receiver section, which afforded a precision method of determining the radial velocity component of the *Ranger* 5 spacecraft.

5. Woomera Station

The Woomera Station had been tracking *Mariner II*, except for three days when the station was relieved, for more than 8 hr every day since 27 August. Operational readiness tests were performed on 10 and 13 October.

New *Ranger* 5 telemetry equipment, a Digital Decommutator Model 2001P, a TTY Encoder Model 4-306A, and three module cases of discriminators, was received and installed in the period 6 weeks prior to *Ranger* 5.

Other equipment received during this period consisted of a new battery charger power supply, a power supply monitor panel, a preplugged patch panel, and a phase comparator.

6. Johannesburg Station

The evaluation tests carried out prior to the launch of *Ranger* 5 were dictated by the fact that the station was engaged in the daily tracking of *Mariner II*; thus, star-tracks were not carried out and RF boresight vs. polarization tests were not required. The tracking feed was fitted in place of the horn feed on the night of 8 October and a dynamic track of *Mariner II* was carried out on 10 and 11 October to assess the tracking accuracy. The station took part in two net integration tests on 10 and 13 October. The acquisition aid was phased-up and tested on 15 October.

The only new equipment installed for *Ranger* 5 was in the instrumentation section where a new telemetry-to-teletype encoder with edit drawer and tape punch were received and installed shortly before the mission.

E. Tracking Operations

At the time of lift-off, the SMS at Cape Canaveral was in RF lock and maintained lock until 170645Z, when the spacecraft set below the horizon. The spacecraft, because of its flight path characteristics, was not again tracked by the DSIF until it rose above the MTS horizon in South Africa. At 173028Z, the MTS acquired the spacecraft transponder in a two-way lock and maintained lock until 173707Z, when it set below the horizon. During this period, from 173152Z to 173530Z, Johannesburg was able to acquire intermittent one-way RF lock. Continuous surveillance of the spacecraft by the DSIF began when Woomera acquired an RF lock on the spacecraft at 174537Z on 18 October (Ref. 3). Subsequent surveillance periods are summarized in Table 13.

Approximately one-half hour after Woomera acquired the spacecraft, analysis of the telemetry data at JPL in-

Table 13. Approximate tracking times during *Ranger 5* mission

Station	Visibility period (date/GMT)
Spacecraft Monitoring	18/1635 to 18/1707
MTS	18/1730 to 18/1737
Johannesburg	18/1732 to 18/1735
Woomera	18/1746 to 19/0220
MTS	18/2231 to 19/0421
Johannesburg	18/2258 to 19/0959
Goldstone Pioneer	19/0836 to 19/1440
Goldstone Echo	19/0846 to 19/1954
Woomera	19/1652 to 20/0155
Johannesburg	20/0032 to 20/1000
Goldstone Echo	20/1020 to 20/2028
Woomera	20/1708 to 21/0244
Johannesburg	21/0034 to 21/1000
Goldstone Echo	21/0900 to 21/1814
Goldstone Pioneer	21/0909 to 21/2045
Woomera	21/1825 to 22/0240
Johannesburg	22/0612 to 22/0730
Goldstone Pioneer	22/1910 to 22/2015
Goldstone Pioneer	23/1309 to 23/1500
Goldstone Pioneer	24/1431 to 24/1455
Goldstone Pioneer	25/1233 to 25/1420
Goldstone Pioneer	26/1202 to 26/1400
Goldstone Pioneer	27/1158 to 27/1340
Goldstone Pioneer	28/1233 to 28/1409
Goldstone Pioneer	29/1247 to 29/1400
Goldstone Pioneer	30/1200 to 30/1325

dicated a loss of the use of solar panel power. This loss of power severely jeopardized the mission success. To optimize the mission results, a midcourse maneuver was indicated for accomplishment as soon as possible. The commands for the maneuver were determined at JPL and supplied to Johannesburg for transmission after they acquired the spacecraft at 225805Z.

Prior to acquisition by the MTS and Johannesburg, Woomera tracked the spacecraft. After initial RF lock, Woomera experienced considerable trouble obtaining a two-way lock on the transponder because points of apparent two-way lock were detected below the predicted frequency.

At 234600Z, Johannesburg began the procedure required for transmission of the midcourse maneuver commands. (See Table 14 for the commands sent and the time of their transmission.) The maneuver was unsuccessful, however, because the spacecraft lost its battery power before completing the maneuver.

Before transmission of the maneuver initiate command at 0129Z, three sets of midcourse maneuver commands were transmitted to the spacecraft by Johannesburg. The first set of commands, transmitted from 2346Z to 2354Z, were those for a standard midcourse maneuver. Subsequently, when it became obvious that the maneuver could not be accomplished by a standard operation, i.e., normal Earth acquisition achievement and roll axis stabilization, a new set of commands, based on a "Sun line" maneuver, were supplied to Johannesburg and transmitted to the spacecraft. Prior to transmission of this second set of stored commands, two antenna hinge angle override commands were sent to the spacecraft. The first command set the spacecraft to respond to commands and the second returned the antenna to its original position.

Table 14. Time of *Ranger 5* midcourse maneuver transmissions from Johannesburg Station

Date/GMT	Command
18/2346	Clear command
2348	Clear command
2350	Maneuver roll duration
2352	Maneuver pitch duration
2354	Maneuver velocity increment
19/0000	Antenna hinge angle override
0020	Antenna hinge angle override
0048	Clear command
0050	Clear command
0103	Maneuver roll duration
0105	Maneuver pitch duration
0107	Maneuver velocity increment
0111	Clear command
0112	Clear command
0116	Maneuver roll duration
0117	Maneuver pitch duration
0118	Maneuver velocity increment
0129	Maneuver initiate command

Failure of the telemetry channel B-20 telemetry discriminator at Johannesburg meant there was no "quicklook" oscillograph indication of correct stored command reception by the spacecraft. The third set of stored commands were then transmitted to the spacecraft. This third set of commands duplicated the second set and increased the probability of accurate command reception by the spacecraft. After receipt of the tape at JPL, processing of the magnetic tape records showed that all stored commands were properly verified by the binary readout on telemetry channel B-20.

During the maneuver command transmission and performance, the DSIF had difficulty staying in lock on the transponder signal. The MTS had acquired the transponder signal at 2231Z on 18 October and maintained lock until 0129Z when the receiver began an occasional loss of lock which continued until 042115Z.

After the spacecraft failed to complete the midcourse maneuver, the DSIF continued with attempts to track the transponder. On 19 October Johannesburg periodically interrupted tracking of the capsule to search for the transponder signal and was able to obtain intermittent locks on the transponder signal from 045640Z until the end of the tracking period at 095900Z. During their view periods on 19 October the Goldstone Pioneer and Echo stations attempted to track, respectively, the capsule and transponder signal. Capsule tracking at Pioneer was generally successful, with signal levels varying from -143.0 to -159.5 dbm. During the transponder search, Echo was able to obtain only occasional locks with maximum signal level of -126 dbm and a maximum in-lock period of 11 min. At 2029Z on 19 October Woomera detected the last transponder signal of the *Ranger 5* mission. After 19 October the DSIF continued to track the capsule signal with attempts to acquire the transponder signal.

On 21 October an attempt was made by both the Goldstone Echo and Johannesburg stations to switch the transponder signal to the high-gain antenna. Between 073047Z and 083840Z, Johannesburg transmitted five RTC-3 commands using 200 w and different VCO frequencies (200-cps changes) for each transmission. Subsequently, during its view period, Echo transmitted 71 RTC-3 commands between 090114Z and 113538Z. The Echo commands were transmitted using 7 kw with the VCO frequency varied in 1-kc steps about both the nominal frequency and a frequency 0.5 kc below the nominal. None of these command transmissions produced any apparent result.

On 21 October, between 1637Z and 1744Z, the Moon occulted the spacecraft. At this time, Pioneer was tracking the capsule signal and logged loss of signal at 163819Z. Echo was searching for the transponder signal when occultation began; however, the receiver was switched to the capsule frequency prior to the end of occultation. The capsule signal was reacquired by Pioneer at 174502Z and by Echo at 174750Z. At Woomera, whose view period began shortly after the start of occultation, receiver lock was delayed until after 1822Z when station personnel were notified of an error in the doppler frequency predictions supplied them.

After *Ranger 5* passed behind the Moon, the DSIF began decreasing coverage. The SMS and the MTS had been secured from the mission on 18 and 19 October, respectively. Echo was secured after its view period on 21 October. On 22 October Woomera and Johannesburg ceased tracking attempts. Pioneer, however, continued attempts to track the capsule signal for a 2-hour period prior to the *Mariner II* tracking period. By 29 October the signal level had fallen to −169 dbm, receiver threshold at Pioneer, and as expected, on 30 October no trace of the capsule signal could be found during the search period. The tracking of *Ranger 5* was terminated on that date.

Detailed accounts of tracking operations at each station are given in the following paragraphs.

1. Spacecraft Monitoring Station

The station was in two-way lock with the spacecraft at L + 20 min at 163516Z. Signal strength at acquisition was −83 dbm. Immediately after acquisition of two-way lock, the ground transmitter frequency was tuned from 29.668166 to 29.668666 Mc to allow for the expected doppler shift of approximately 1000 cps.

Acquisition went very smoothly even though the tracking conditions were not very good. It was an overcast day and the launch vehicle could not be seen. Therefore, a plot of elevation and azimuth vs. time was used to position the antenna. Station performance was satisfactory.

There were no changes in tracking conditions during the launch phase. The conditions of receiver telemetry during launch phase were very good and all channels were in lock until 170645Z. The launch tracking was smooth, and there were no difficulties. The spacecraft was successfully tracked for 458 sec and the average signal level variation during this time was −85 to −130 dbm. This is what has been experienced in all other launches to date. No unexpected significant events occurred.

2. Mobile Tracking Station

After two postponements, the *Ranger 5* launch occurred at 1659Z on 18 October. Since the first tracking period was expected to be quite brief and a maximum amount of two-way doppler data were required, it was decided to acquire the spacecraft receiver on the horizon. The transmitter frequency for two-way lock was calculated and the VCO set to the proper frequency. First RF lock occurred at 173028Z. At this time it was found that two-way lock had been accomplished since the spacecraft receiver had already acquired the ground transmitter. The two-way lock indicator performed properly during the entire pass, giving none of the erroneous indications noted during the *Ranger 4* mission. The transmitter was biased up to center frequency and the data condition switch moved to GOOD at 173120Z. All systems were "green" at acquisition plus 52 sec. The first pass of *Ranger 5* ended when the receiver lost lock at 173707Z. For this pass, data were on a 5-sec sample rate and a 5-sec continuous doppler count. All tracking data for this pass was teletyped to JPL. Tracking conditions and telemetry conditions were both good.

The second pass of *Ranger 5* began with RF acquisition at 223100Z. Tracking appeared normal; however, net control reported that at least one solar panel was not putting out voltage. Telemetry channels were in lock at 223730Z, channels 5 and 6 were below threshold, channel 2 was 50% in lock, and all other channels were close to threshold. An attempt to send the midcourse maneuver command was made by Johannesburg. The execute command (RTC-4) was sent at 012900Z. The receiver dropped lock at 012950Z and was in and out

of lock numerous times during the next three hours. About 0145Z the transponder signal gave indications that the spacecraft battery was failing. The transponder signal was locked up intermittently and at varying frequencies and signal strengths. The transponder was last heard at 942115Z at a signal strength of −154 dbm. A search for the signal was continued until 0752Z, at which time postflight calibrations were started. The station was secured at 0845Z.

3. Goldstone Pioneer Station

At 0817Z the receiver started searching for the spacecraft capsule. The servo went to the slave mode at 08240Z. The receiver locked on to a sideband at 083550Z and remained on the sideband with varying signal strengths of from −143 to −151 dbm until 0921Z. The receiver locked on to the capsule carrier at 092139Z. Receiver signal strengths varied from −143 to −159.5 dbm until the end of the tracking period at 1440Z. Bad commands from the computer at 135445Z sent the servo to the aided track mode until 140045Z. No equipment failures were reported during this tracking period.

The Pioneer Station did not participate in the second tracking period because of commitments to track *Mariner II*.

The third tracking period began with the receiver reporting a lock condition on the capsule signal at 090840Z. A discriminator No. 2 lock condition was reported at 0913Z. Signal strengths varied from −153 to −165 dbm with occasional loss of lock until 093350Z when the receiver went out of lock with the capsule in order to try and acquire the transponder. With no success, the receiver was returned to capsule tracking at 101807Z and continued in and out of lock with the capsule until 113840Z. At this time, a search was again begun for the transponder. This was unsuccessful, so the receiver was returned to capsule tracking and a lock condition at 120710Z. Received signal strengths continued near threshold. At 1420Z, the receiver started going in and out of lock and, except for a period from 163819Z to 174502Z when the receiver was out of lock as the spacecraft passed behind the Moon, continued to do so until the end of the view period.

The *Ranger 5* fourth tracking period started 22 October at 1100Z. The servo system was operated in aided track because no prediction data were available. The doppler mode was placed to nondestruct at the beginning of the countdown. Data and telemetry sections began recording at 1340Z when the receiver started searching for the capsule. At 1520Z, since the *Ranger 5* capsule could not be acquired, the receiver was switched to the *Mariner II* frequency and *Mariner II* was tracked until 1900Z when the search for the *Ranger 5* capsule was resumed. An RF lock was obtained at 190940Z using a receiver time constant of 10 sec. Data and telemetry were turned on at 1910Z. The signal strength was fluctuating near threshold and the receiver continued in and out of lock with signal strengths near threshold until the end of the view period at 2015Z.

The *Ranger 5* fifth tracking period started 23 October when an RF lock on the capsule signal was reported at 130930Z. Servo was in slave mode at 131446Z. At 132440Z it was discovered that the coordinate converter computer was operating with the wrong program. After insertion of the correct program, the receiver obtained a lock condition at 132827Z. Bad commands from the computer at 1332Z sent the servo to the aided track mode until 1407Z. Receiver in-and-out-of-lock condition started at 132536Z and continued with signals near threshold until the end of the tracking period.

The sixth tracking period started 24 October at 143120Z, when the receiver reported a lock condition with the capsule with a signal strength of −160 dbm. The receiver went out of lock at 143826Z. A receiver in-and-out-of-lock condition continued until the tracking period was terminated at 1455Z.

From the seventh tracking period through the final twelfth tracking period conditions were similar to the sixth tracking period with gradually diminishing time in lock. The last firm RF lock was reported at 1233Z, during the tenth tracking period. From that time on only momentary locks were reported. Tracking efforts were terminated at 1325Z on 30 October.

4. Goldstone Echo Station

The first tracking period at the Goldstone Echo Station (Fig. 53) started 19 October. Word had been received that a malfunction had occurred in the spacecraft power system.

At 0834Z, the telemetry recorders were turned on and the receiver started searching for the *Ranger 5* transponder, acquiring it for 30 sec at 090822Z. The receiver continued in and out of lock with the transponder for short lengths of time throughout the entire tracking period. At 091907Z, the receiver operator reported that the received frequencies were fluctuating. At 094540Z, the receiver went in lock and stayed in this condition

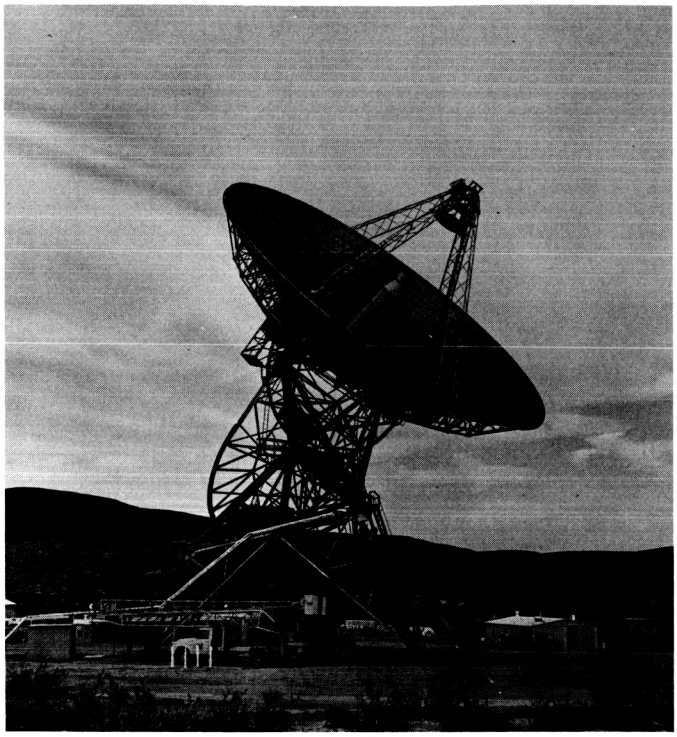


Fig. 53. Goldstone Echo Station's 85-ft HA-Dec antenna

for 7 min. During this in-lock time, telemetry was able to obtain a rate one and two sync condition and received signal strengths varied from −126 to −150 dbm. Telemetry rates one and two syncs were again obtained at 110827Z for a period of 6 min.

At 1532Z, the receiver acquired the capsule signal at a signal strength of −148 dbm. The receiver went out of lock with the capsule at 1705Z in order to attempt to acquire the transponder. The RF tracking filter bandwidth was switched from 20 to 60 cps. The transponder was acquired at 171740Z, and the transmitter was turned on and began sweeping at 171815Z. The receiver continued in and out of lock. The tracking period was terminated at 201540Z.

The second tracking period started 20 October with the receiver searching for the capsule signal at 0840Z. The servo system was taken out of slave to the program tape at 095223Z to aid the receiver in searching for the capsule. Receiver personnel reported an in-lock condition at 101958Z, but the received signal was very weak and the receiver continued in and out of lock searching for the capsule until 103351Z. At this time an attempt to acquire the transponder was made but was unsuccessful. The receiver was relocked on the capsule signal at 114052Z. Except for unsuccessful attempts to acquire the transponder the receiver was maintained in an in-and-out-of-lock condition with the capsule for the remainder of the tracking period. Received signal strengths varied from −144 to −152 dbm.

The third tracking period started 21 October at 0855Z. At 090114Z, with the servo in the slave mode and the transmitter operating at full power, an RTC-3 command was initiated. By 093348Z, 23 RTC-3 commands had been transmitted at 1-kc increments. A 10-sec nondestruct doppler count was begun at 0950Z. At 0951Z the data sample rate was changed to 10 sec. Receiver personnel obtained a partial receiver lock at threshold for 7 sec at 100506Z. At 100522Z, the transmitter again started initiating RTC-3 commands at 1-kc increments. By 113538Z, 48 commands had been sent, totaling 71.

At 1137Z, the receiver switched to the capsule frequency and began searching for the signal. A receiver in-lock condition was reported at 113850Z with a signal strength of −157 dbm. The receiver continued in and out of lock with the capsule until 132216Z when the receiver switched to the transponder frequency. After attempting to acquire the transponder with no success, the receiver switched back to the capsule frequency at 1509Z. Tracking continued for the remainder of the view period with the receiver switching back and forth between the capsule and the transponder. At 171325Z, the servo went to the aided track mode due to bad computer commands. At this time the spacecraft had been occulted by the Moon, and the station was searching for the capsule signal. (Occultation began at 1637Z while the station was searching for the transponder signal.) The capsule was reacquired at 174750Z after occultation ended. Tracking continued with in-and-out-of-lock conditions until the receiver operator reported signal strengths at threshold. *Ranger* 5 tracking was then concluded, and the *Mariner II* signal acquired at 181430Z.

5. Woomera Station

The *Ranger* 5 mission provided the second opportunity for operational use of the acquisition aid. Its operational value had been considerably improved by providing a monitor receiver for the 85-ft dish while the main receiver was switched through to the acquisition aid. This avoided very nicely the *Mariner* occurrence whereby the spacecraft overran the antenna by 7 deg, passing right through the 85-ft dish beam, before enough confidence could be placed in the acquisition aid error signals to go to autotrack and then acquire the 85-ft dish beam.

An additional acquisition technique used was to position the antenna at 85 deg HA rather than 90 deg. This had the advantages of being well away from prelimits and of being at a reasonable elevation (9 deg at 352 deg Dec) so that the acquisition aid error signals would tend to be meaningful. Aircraft tracks had demonstrated that acquisitions from misalignments of 7 deg from this point (HA 85 deg, Dec 352 deg) could be made reliably. Larger misalignments would be tried in the future.

Ranger 5 initial acquisition was made very smoothly; the antenna was at the acquisition point 10 min before expected acquisition and was in the acquisition aid mode, switching to the 85-ft dish momentarily at 5-sec intervals, to provide for the possibility of a near nominal trajectory at low signal level. The signal was acquired and the 5-sec switching stopped at 174537Z, when the spacecraft was on the horizon. The signal level was then −137 dbm. After 83 sec the signal appeared in the 85-ft dish monitor receiver and the acquisition aid was switched out; the signal level rose from −124 to −102 dbm. When the error signal polarities were correct 13 sec later, the servo was switched to auto; and at 174727Z the snap-on completed a perfect acquisition.

The acquisition aid was used twice more during the first pass. At 175423Z the antenna overran the spacecraft while the receiver was out of lock. The acquisition aid was switched in and at 175845Z the 85-ft dish reacquired. There was unnecessary delay in switching to auto mode following receiver acquisition at 175548Z, and not enough use was made of the extremely good predictions.

The third use of the acquisition aid occurred at 180030Z when it was thought that an 85-ft dish side lobe acquisition had occurred. This could have been simply checked by noting the 20-db drop in signal level on switching to the acquisition aid, but unfortunately this clear indication was not used and the system stayed in the acquire mode until 180201Z.

The transmitter was turned on at 174800Z and two-way acquisition occurred 8 sec later when the ground receiver reacquired following loss of lock at 174803Z. After 65 sec the ground receiver lost lock. The station finally achieved good two-way lock at 183530Z.

Subsequent investigation indicated that the delay in obtaining two-way lock occurred because the transmitter VCO was not tuned properly. The standard search procedure for the transmitter VCO is to start 500 cps below the expected acquisition frequency and search upward until the ground receiver drops lock or experiences a phase transient. In the case of *Ranger* 5, points of apparent two-way lock (pseudo lock) were found below the predicted frequency; consequently, the search was concentrated in that area. Except for one instance, at 1809Z when the transmitter VCO was near the nominal frequency and the spacecraft AGC indicated a normal signal level of −92 dbm, the spacecraft receiver AGC indicated a low signal level of −137 to −139 dbm. Near threshold conditions of the transponder were also indicated by the tuning rate, which approached 750 cps, causing loss of pseudo lock. (Normally, at the expected signal levels of −90-dbm tuning rates of the ground transmitter in excess of 5 kc could have been tolerated.) These pseudo lock points might have been due to a spurious RF response of some sort in the communication link.

After successful two-way acquisition, tracking continued in this manner until approximately 2330Z on 18 October when Johannesburg obtained two-way lock. From 2330Z on, Woomera tracked the transponder signal, except for one period of capsule tracking from 0114Z to 0121Z on 19 October until 0148Z when the transponder signal went below receiver threshold. Capsule tracking was resumed at 0158Z and continued until 022011Z when the receiver went out of lock just before the antenna actuated the prelimit switches.

At 202211Z the transmitter VCO drift problem was aggravated by interference from the air conditioning system. The drift rate rose to 1.6 cps per min and did not stabilize for more than 20 min. No action was proposed on the air conditioning system because of the extensive building modifications which were expected in the following year.

At 010620Z the Gertsch was accidentally switched off while wrestling with the paper tape resulting from the 1-sec sample rate. The fact that this was not corrected until 014500Z is an indication of the state of fatigue then existing and the considerable activity involved throughout the station in reacting to the behavior of the spacecraft and the requests of Net Control. The run out of both magnetic tapes at 020100Z may be attributed to the same reason. However, the latter could have been avoided by the installation of a loud alarm which operates if the tapes are not changed soon after the correct time.

The second pass on 19 October was spent alternately searching for transponder and capsule. The sequence

varied somewhat at the instruction of Net Control, but generally 15 min were spent on the capsule and one hour on the transponder.

The transponder was acquired one way on several occasions, but never for more than 5 min. Last contact of any length was at 2019Z.

The first 3-3/4 hr of the third pass on 20 October were spent tracking the capsule. Signal levels were again around −154 dbm and capsule lock was regularly maintained for 6 to 7 min before the signal fell below threshold, only to reappear a minute or so later.

Two transponder searches of 30-and 40-min duration were unsuccessful, and the remainder of the time was spent on the capsule. Generally, the latter half of the pass showed slightly lower signal strengths, around −156 dbm, and lock periods of only about 2 min.

The fourth pass on 21 October involved first acquisition from behind the Moon. Acquisition was hampered by clouds since the TV monitor picture of the Moon was not available to assist in positioning the antenna. But the most significant difficulty was the more than 600-cps erroneous predictions of doppler mixer output.

Once the error in predictions was corrected by Net Control, acquisition was readily made, and the pass proceeded very much as the third pass except that no transponder searches were made. Lock periods of 6 to 7 min were quite typical. The station secured at the end of this tracking period.

6. Johannesburg Station

At Johannesburg, spacecraft signals were acquired on 18 October at 173152Z, and the servo was in auto on the acquisition antenna from 173220Z to 173530Z when the signals were lost over the eastern horizon. The signal strength at acquisition was −105 dbm. Lock on the main antenna was not obtained, probably due to the acquisition antenna pattern being distorted by ground deflections.

The second tracking period started on 18 October with acquisition occurring at 225805Z with a −132-dbm signal strength. The transmitter was switched on at 232757Z and two-way lock was verified at 232907Z. However, the receiver lost lock and two-way lock had to be verified again at 233035Z. The following commands were transmitted to the spacecraft: RTC-0, SC-1, SC-2, SC-3, RTC-0, RTC-0, SC-1, SC-2, SC-3 and RTC-4. RTC-4 was transmitted at 012900Z, and the receiver lost lock at 012949Z. From this time on, the receiver went in and out of lock with the transponder and two-way operation was impossible.

At 023640Z the receiver was locked up on the −142-dbm beacon signal, and lock was maintained until 034713Z when signals faded. Alternating searches were made for transponder and beacon signals until the spacecraft was lost over the horizon at 0959Z.

During the third tracking period on 20 October the capsule signals were acquired and autotrack achieved by 003740Z. Searches were conducted for the transponder and capsule signals as scheduled (1 hr for transponder, 15 min for capsule). During the tracking period the capsule signal strength varied between −146 and −155 dbm. No transponder signals were received. End of track occurred at 1000Z.

On the fourth tracking period acquisition occurred at 003429Z on 21 October with an average capsule signal strength of −153 dbm. The transmitter was switched on at 072845Z and five RTC-3 commands were transmitted at frequencies 200 cps apart on the transmitter VCO. The search for the transponder was again successful. During the tracking period both the 30.5065-Mc bias oscillator and 455-kc oscillator frequencies were recorded.

The fifth tracking period started 22 October. Signal levels varied between −151.5 and −155 dbm during the tracking period. Capsule signals were acquired at 061205Z, and tracking was intermittent until the station was secured from the *Ranger* 5 mission at 0730Z on 22 October.

F. Performance Evaluation

1. Angular Data

The angular tracking data from Woomera and Johannesburg were analyzed soon after the *Ranger* 5 mission. Except for those taken during the first view period, the data were very noisy, which was expected because of the relatively low spacecraft signal level. For the first pass, the angular data from Johannesburg were normal, but the hour angle data from Woomera were bad. Examination of the recording of the servo system error channels did not indicate excessive drift. Low

gain in the servo loop, however, is a possible explanation for the error channels not revealing the excessive variations in the hour angle data.

2. One-Way Doppler Data

Because of the spacecraft malfunction, the DSIF could not interrogate the transponder; consequently, only one-way doppler data were available for the major portion of the mission. Normally, this type of doppler is not used in determining the spacecraft orbit, but for this mission it was critically needed to verify the computed orbit and to verify occultation time.

To use the one-way data, the frequency of the 30-Mc bias oscillator should be known. Unfortunately, a record of this frequency was not made. Probably the failure to monitor the bias oscillator was due to the operational necessity of monitoring the 31-Mc receiver reference VCO. That is, in cases of low received signal strength, the 31-Mc VCO frequency is used as an aid to determine whether the receiver is locked on the spacecraft signal. Because the station configuration at Pioneer provided for monitoring only one frequency at a given time, the bias oscillator frequency was not monitored.

3. Two-Way Doppler Data

Two-way doppler data were obtained from Woomera and Johannesburg during the early portion of the mission before the transponder signal became intermittent. The doppler residuals for both stations appeared satisfactory, and the standard deviations compared favorably with those observed in previous missions. During a portion of the period when two-way doppler data were obtained, a drift in excess of the specified 1 part in 10^8 per 15 min was observed in the transmitter VCO at Woomera. The VCO drift rate at Johannesburg was normal.

The received signal level was continuously decreasing since a switch to the high-gain antenna did not occur. The received signal levels, as indicated by AGC voltages, were checked against space-loss-predicted values with reasonable agreement.

4. Time of Closest Approach and Occultation

Data from Pioneer were analyzed for 21 October and the time of closest lunar approach and time of occultation determined. Plots of one-way doppler data show that closest approach to the lunar surface occurred at 155702Z. The oscillograph records show occultation occurred at 163816.1Z, and the spacecraft signal was reacquired at 174458.4Z.

5. Equipment Problems

Summarized below are the equipment problems encountered at each DSIF station during the *Ranger 5* mission.

Mobile Tracking Station. The only trouble experienced at the MTS during the mission occurred when switching to the destructive doppler mode at 011500Z a faulty binary counter board was discovered. Less than 2 min of data were lost while the board was replaced.

Goldstone Pioneer Station. All equipment operated normally during the first *Ranger 5* view period. At 1708Z of the third view period on 21 October, a failure occurred in the BRPE high speed punch. The defective punch was replaced and the system returned to normal operation.

All equipment functioned with no operational problems from 21 to 28 October. At 1000Z on 28 October an intermittent failure occurred in the secondary punch logic (PC-143). Attempts to repair the equipment were not successful until after the tracking period was completed. A detailed check revealed an excessive equipment heating problem in the PC-143 logic circuitry due to poor air ventilation. Additional fans were installed to lower the equipment temperature, and the system operation returned to normal.

The maximum maser gain determined prior to the *Ranger 5* mission was 19.5 db. Therefore, the maser was operated with a gain of 18 db and the parametric amplifier operated with a gain of 22 db. To eliminate maser-parametric amplifier gain drift from interfering with the measured spacecraft signal strength, the gain was reset prior to each acquisition period. The maser-parametric amplifier gain was checked after each tracking period and adjusted for deviations if found. The parametric amplifier gain was adjusted to compensate at intervals of 15 min. The maser-parametric amplifier deviation was recorded prior to each setting. The only operational difficulty occurred during the countdown of 24 October when the maser could not be filled due to a faulty transfer tube. A normal fill was performed using a transfer tube borrowed from the Goldstone Venus Station.

Goldstone Echo Station. On 18 October, the transmitter coolant pump failed due to excessive pump motor current. Checks revealed that the pump and motor were noisy; these units were replaced and the transmitter returned to normal operation.

On 21 October, the requirement of 10-kw operation for command transmission necessitated changing the temporary low power RF transmission line between the transmitter and the antenna feed with the original 10-kw high power RF transmission line.

With the exception of the improper operation of the 115-v 400-cps voltage meter on the servo monitor panel during the 19 October tracking period, the entire servo system functioned normally during the pre-launch and post-launch operation. This unit was not repaired until after the tracking period because no spares were available.

Occasional loss of program in the computer during the *Ranger 5* mission was due to RF radiation or static discharge causing the contents of the memory to shift. Other than this difficulty, the entire computer system functioned normally during prelaunch and postlaunch operation.

A failure in the No. 1 doppler counter on 18 October launch countdown rendered the unit inoperative. Replacement of the ST-35 module board corrected the malfunction.

The power monitor meter disclosed a failure in the programmer PC-141 +1-v bias supply on 18 October. Replacement of the defective module board with a spare corrected the malfunction.

During the first tracking period, counter No. 2 was reported operating improperly at 1720Z. This problem was corrected at the end of the first view period by adjusting the Schmitt trigger sensitivity.

The discriminator power supply located in case T2A1 became inoperative at 1659Z on 18 October. A spare discriminator power supply was installed to return the system to full operation. Replacement of two 1N1763 rectifiers repaired the removed unit.

A failure occurred in the universal power supply located in cabinet 13A141 during the third tracking period. Replacement of the power supply with a spare unit returned the system to full operation. Cause of the power supply failure was attributed to a burned out transformer. Except for the power supply failure, the entire system functioned normally during prelaunch and postlaunch operation.

During the early portion of the launch period, a failure occurred in the klystron at 1600Z on 19 October and was replaced prior to first acquisition. The parametric amplifier did not return to normal operation and was replaced before initial acquisition.

Tuning the parametric amplifier was necessary during the second and third view periods because of the low 12-db gain. After tuning, gain was up to 19 db.

During the first and second view periods excessive noise in the receiver was caused by the use of the low power, RF line by the transmitter. The noise was eliminated when, in order to transmit commands to the spacecraft during the third view period, the temporary low power line of the transmitter was replaced with the old high power RF line.

A receiver counter switch produced transients which caused loss of lock in the doppler frequency shifter loop at 0844Z on 21 October. Movement of the switch for the remainder of the third view period was held to a minimum.

Woomera Station. New *Ranger 5* telemetry equipment received and installed in the period six weeks prior to *Ranger 5* comprised a Digital Decommutator Model 2001P, a TTY Encoder, Model 4-306A, and three module cases of discriminators. The installation was complicated by several factors. Owing to the continuance of the *Mariner II* mission, a good deal of the checkout had to be performed between 8 PM and 6 AM with only some three weeks in which to carry out the final installation and checkout. Also, slides for mounting the decommutator in the racks were not received with the equipment. This meant that initially the decommutator had to be operated on a table behind the racks. In addition, it was discovered during the checkout that a series of field changes had altered the decommutator. Information relative to these changes was not received until a few hours prior to the final countdown for *Ranger 5*.

The decommutator was checked out first and appeared to be working correctly. Checks verified that the digital printer readouts were valid and also that the measurements shown on the digital printer record agreed

with the oscillograph recordings. Owing to the deficiencies mentioned above, these checks were not as thorough as they might have been.

When the TTY encoder was switched on, it was discovered that the measurement commands from the decommutator were not driving the encoder, with the result that there was no output from the encoder, unless program A was used. It was discovered that the amplitude of the measurement command pulses was too low, and that field change E, in which 1k resistors were to be substituted for 10k resistors in Q-100 cards, had not been accomplished on the decommutator. This modification, involving some 70 resistors, was made locally, and on completion several deficiencies were found to exist. The "position" digit of the measurement address was found to have stuck on 9 on the digital printer record. On the TTY page print, a letter shift occurred in the "position" digit of the printout. Also, although the TTY encoder was now accepting the measurement commands direct to the "OR" gate in the patch panel, the editor flip-flops gave a very erratic performance.

The cause of all these malfunctions was found to be due to a static 1.3-v negative bias on all the measurement commands. After various attempts to remove the unwanted bias, it was discovered that the common points on all the Q-100 cards were not joined to the rest of the common system in the multiplex drawer. The measurement commands were all floating on a static bias which was derived through the circuit impedances of the Q-100 cards. The bias must have been present prior to field change E but of lesser amplitude. On restoring the missing connection to the common lead on the Q-100 cards and restoring certain cards which had been modified during the above tests, a considerable improvement was achieved in the operation of the system as a whole. However, efforts to eliminate all the corruptions on the TTY page print prior to the mission were not completely successful.

Nearly all the trouble which the TTY Encoder equipment appeared to give during checkout was traced to the decommutator. The only logic fault was in an L-308 card in the time readout logic, and this was cleared easily by card replacement.

The absence of any form of test facility on the encoder was a disadvantage. A test box, made up locally so that fixed digits of time and data could be fed into the encoder, was particularly useful in checking out the high speed punch.

After replacing a number of fuses and a few output tubes, the discriminators gave much less trouble than expected. Wow and flutter compensation, using a channel 4 discriminator, was tried out on *Ranger 5* test tapes and proved to be very effective.

Processing at JPL of the magnetic tapes received from Woomera revealed the peaks on the signals from the time code generator and the spacecraft telemetry VCO's were clipped for the entire first pass. This was caused by failure to check the signals for proper amplitude.

Johannesburg Station. On 18 October, the spacecraft was acquired as it rose above the horizon; but, for some 50 deg in HA, it was beyond the north declination limit. During this time the spacecraft was tracked in auto on the acquisition aid with declination locked off. When the spacecraft rose out of the limits of the antenna, several attempts to switch to the main beam failed, and it is believed that the cause was that the elevation angle was small and multi-path effects degenerated the tracking accuracy. The system continued to operate satisfactorily until the third day of the mission when a low speed tachometer bearing on HA seized and was replaced.

During the second pass on 18 October when sampling at a 1-sec sample rate, destructive doppler count, a fault in the number one counter logic resulted in bad data on alternate counts.

During the transmission of the midcourse maneuver commands on 19 October, telemetry channel B-20 blip signal verification of stored command reception by the spacecraft was not possible because of a failure in the B-20 channel discriminator. A wrong input signal had been applied to the discriminator during testing and caused an excessive output to the galvanometer. The latter is usually protected by a 15-ohm parallel resistor, but this resistor had become open-circuited. Later examination showed that many of these 1-w resistors were burned out.

G. Participation of Non-DSIF Agencies

1. Space Flight Operations Center

All spacecraft command and monitor functions took place in the Space Flight Operations Center at JPL, where spacecraft data were analyzed, evaluated, and interpreted. Additional support was provided by the Central Computing Facility, which reduced all *Ranger 5*

tracking and telemetry data to usable form. Communications were again controlled by the Communications Center, which handled all communications circuits providing data flow to or from any DSIF station and/or operational unit at JPL.

2. Atlantic Missile Range

The AMR was assigned the responsibility of providing JPL with orbital elements of the parking and transfer orbits; acquisition information for the MTS, Woomera, and Johannesburg stations; and the raw data that would be used by JPL to provide a backup to the computations of the transfer orbit.

Uprange stations (Puerto Rico and San Salvador). Good data were received from the uprange tracking stations. The *Agena* C-band radar was first acquired by the Cape radar 12 sec after launch. Except for short out-of-lock periods, the C-band radar tracking by both of the uprange stations was successful. The data were sent to AMR from Puerto Rico and were used for acquisition and prediction information for Ascension.

Downrange stations (Antigua, Ascension, Pretoria, and Ship Uniform, ORV 1886). Antigua began receiving coast data at the first *Agena* burnout and continued to receive data until loss of lock when the *Agena* set below the horizon. This information yielded 39 useful data points. The launch trajectory was such that the *Agena*'s highest elevation angle at Antigua was 8½ deg. Ascension did not see the *Agena* rise higher than 4.2 deg; notwithstanding, the data obtained from Ascension from 171936Z to 172324Z on 18 October yielded 38 data points, all of which were free of gross errors.

The *Agena*'s highest elevation angle at Pretoria was 12 deg, and its closest approach was 810 km. By the time of the second *Agena* burn, it was so low on Pretoria's horizon that the station only achieved intermittent lock with the C-band radar. These data were poor and, therefore, not used by either AMR or JPL.

The computer on board the Ship Uniform, ORV 1886 (formerly the Twin Falls Victory ship) malfunctioned; therefore, the data recorded there were available within an hour at JPL. During the ORV 1886 view period, from 172633Z to 174141Z, on 18 October, 51 data points were received from the *Agena*. Several of the range readings and several angles had gross errors and were discarded. The *Agena*'s elevation angle reached a 25-deg maximum and the probe came within 700 km of the ORV 1886. The data received by the ORV 1886 were used by JPL to determine an orbit; however, because of a program error, it was not possible to combine these data with the DSIF data to adjust for the ship's position. An approximate adjustment was made later, however, changing the ship's coordinates.

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APPENDIX

Operations Summary for *Ranger* Missions 1–5

I. *RANGER 1* OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-1–A-7) for the *Ranger 1* space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary in the form of edited station logs. Throughout the summary (Table A-1) the space communication stations of the DSIF are identified by the following code numbers which were in effect at the time of the mission:

DSIF 0 – Spacecraft Monitoring Station

DSIF 1 – Mobile Tracking Station

DSIF 2 – Goldstone Pioneer

DSIF 3 – Goldstone Echo

DSIF 4 – Woomera

DSIF 5 – Johannesburg

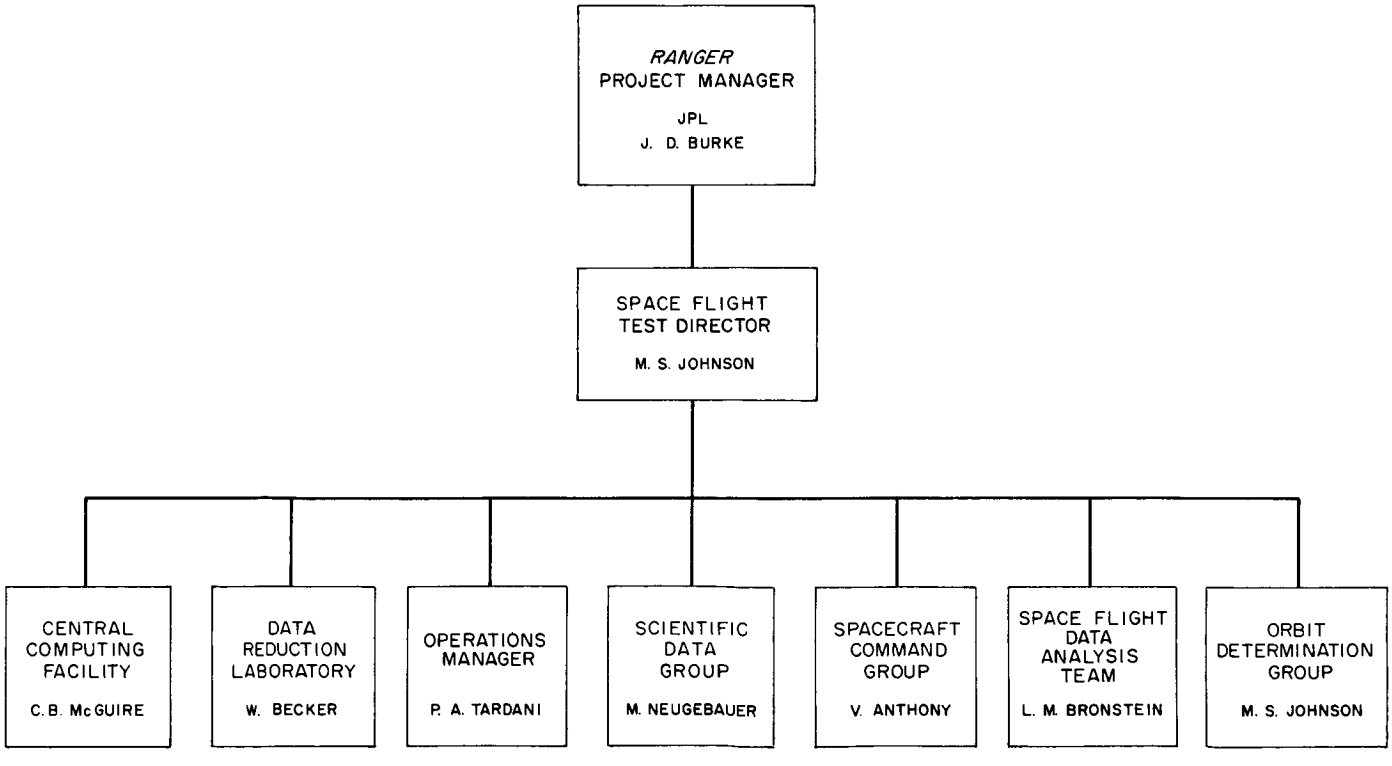
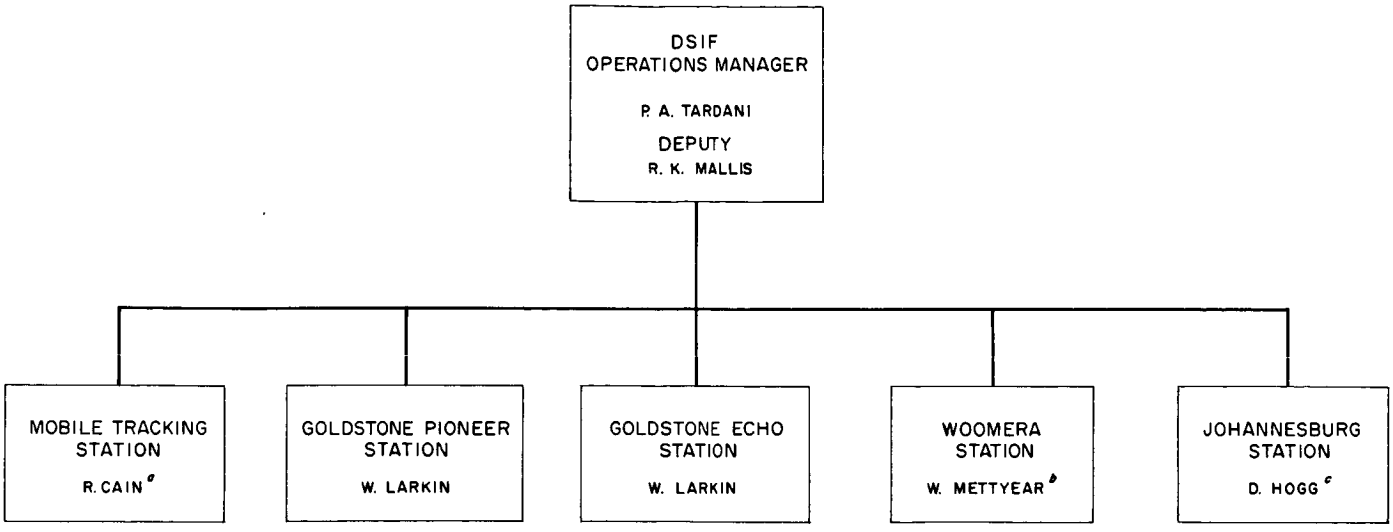


Fig. A-1. Space flight operations organization for *Ranger 1*



[a] BENDIX CORPORATION

[b] WEAPONS RESEARCH ESTABLISHMENT OF THE DEPARTMENT OF SUPPLY, COMMONWEALTH OF AUSTRALIA

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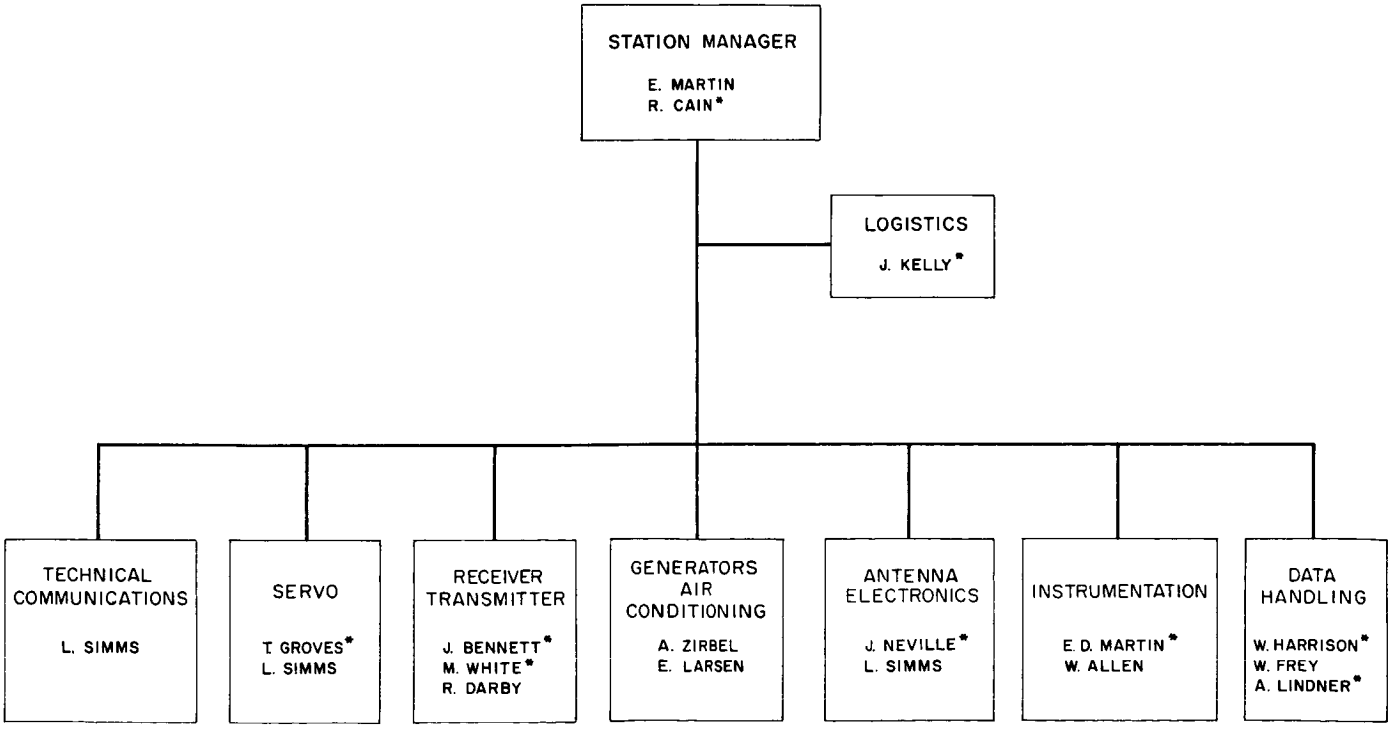
Fig. A-2. DSIF operations organization for *Ranger 1*



*BENDIX FIELD ENGINEERING CORPORATION

Fig. A-3. Mobile Tracking Station organization for *Ranger 1*

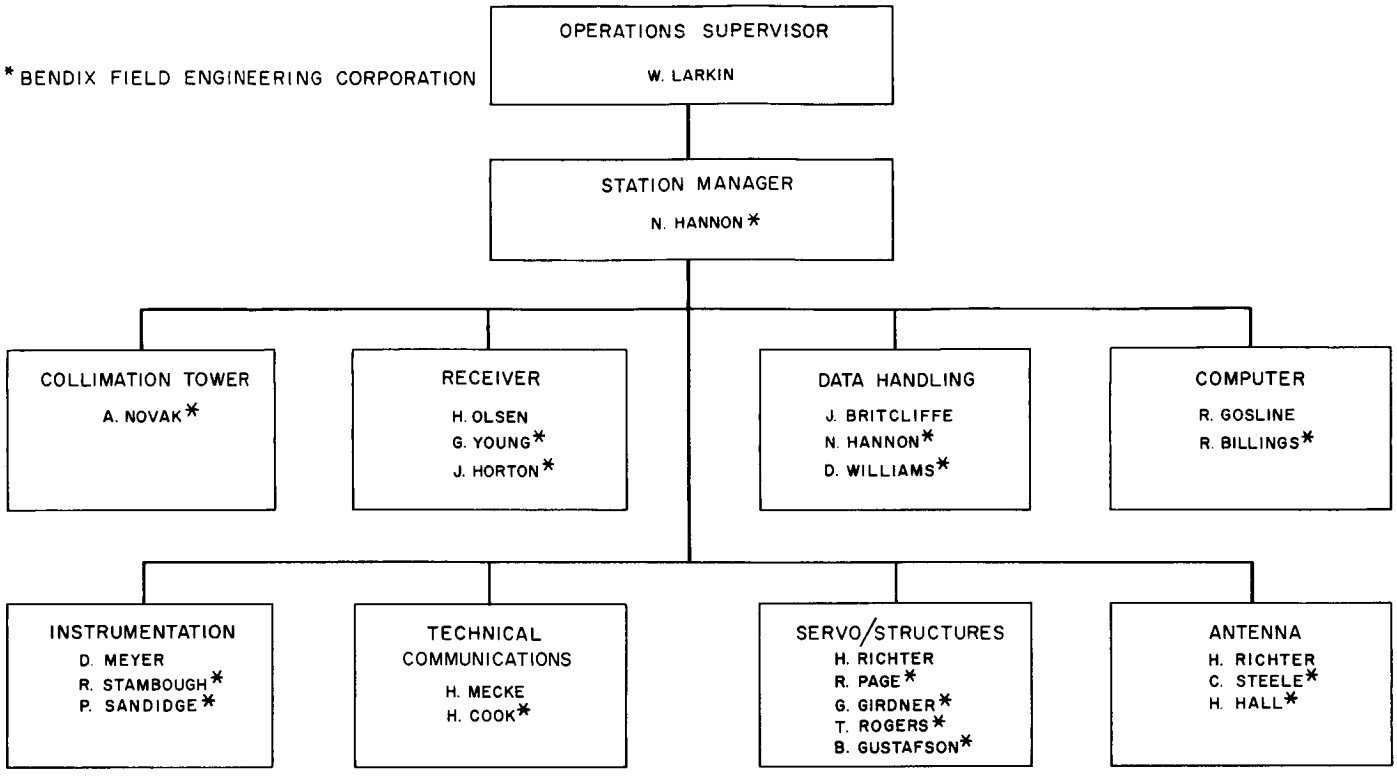


Fig. A-4. Goldstone Pioneer Station organization for *Ranger 1*

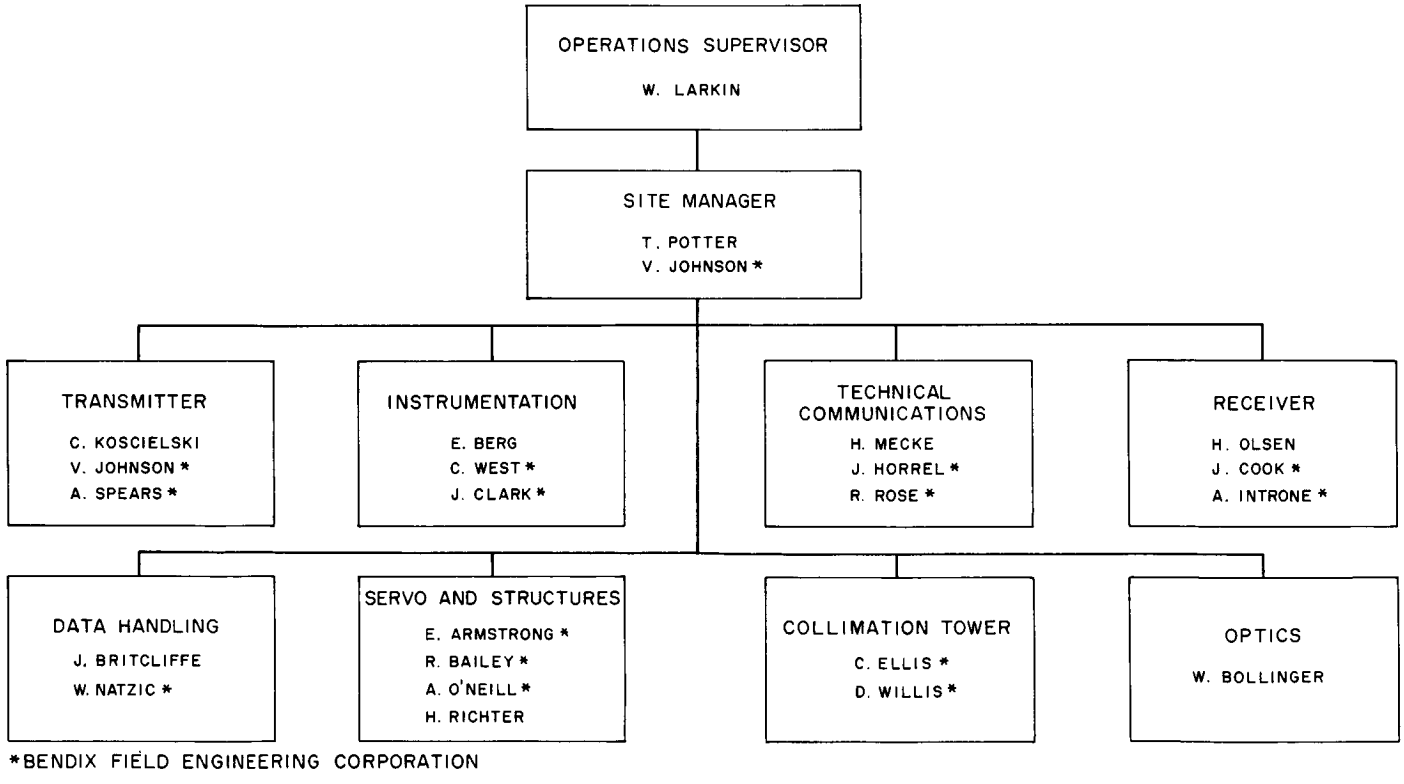


Fig. A-5. Goldstone Echo Station organization for *Ranger 1*

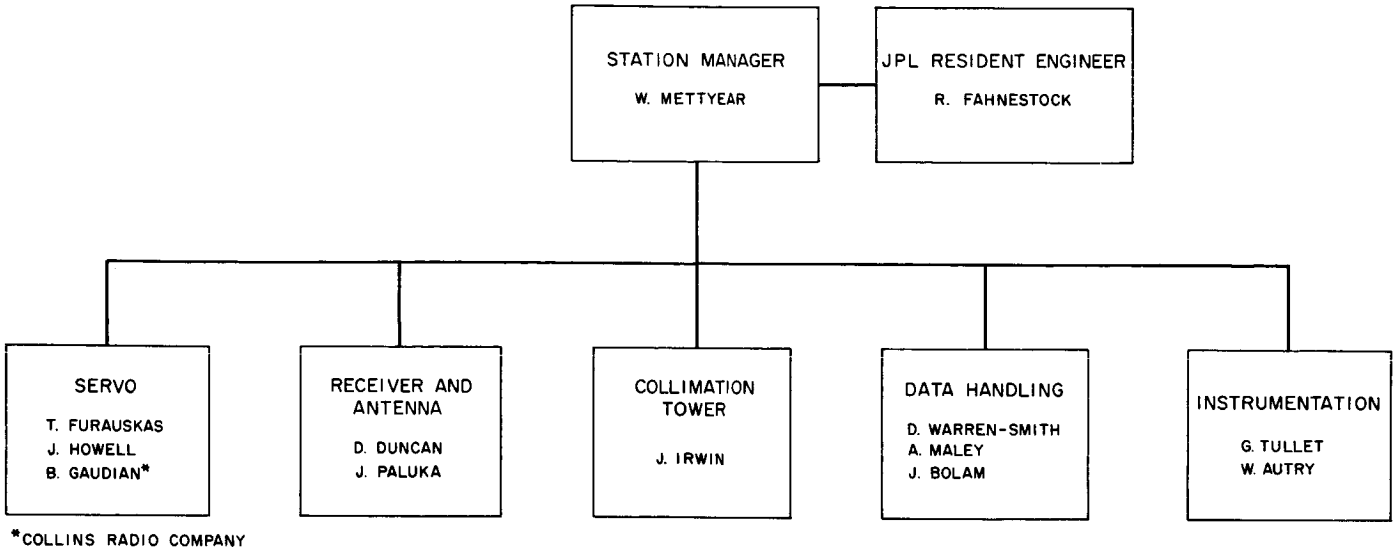


Fig. A-6. Woomera Station organization for *Ranger 1*

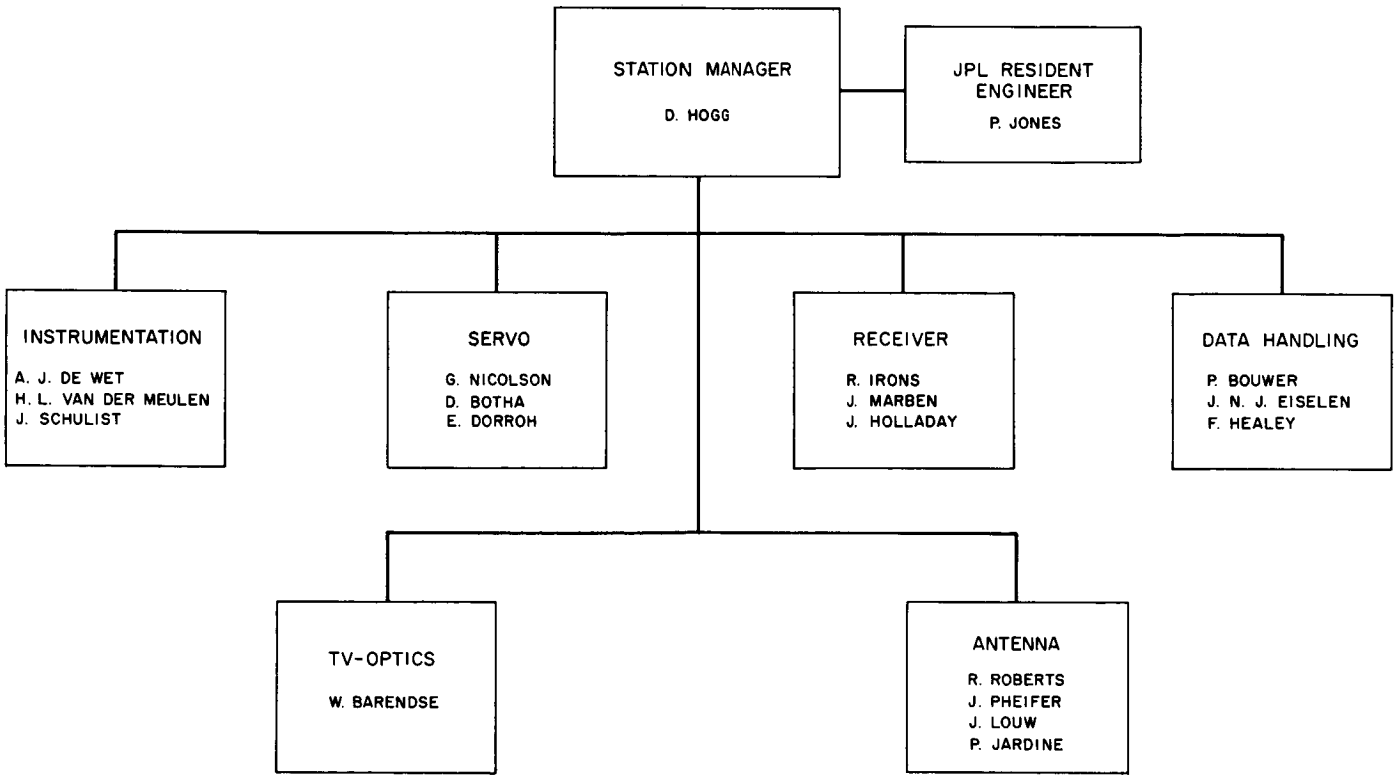


Fig. A-7. Johannesburg Station organization for *Ranger 1*

Table A-1. *Ranger 1* tracking operations summary

Date, Aug	Sta	Orbit	RF reception time, GMT						Signal, dbm	Remarks
			One-way		Two-way		Autotrack			
			In	Total	In	Total	In	Total		
										Launch
23	1	1	10:36:11	—						Four intermittent locks (30 sec max)
	5	1	10:39:31	—						Momentary lock
	3	1	11:31:33	—						
	2	1	11:35:26	00:11						Transponder acquired
	1	2	12:11:31	07:10			12:11:41	07:00		On transponder; no lock on Chan 7.7; on beacon to end of pass
	2	2	13:08:22	06:04			13:08:22	06:04		
	3	2	13:08:15	06:37			13:08:15	06:15		Telemetry normal
	1	3	13:46:57	08:54			13:46:57	08:54	−116	Lost autotrack for 10 sec; 8 min good telemetry
	1	4	15:22:20	04:20			15:22:41	09:50	−111	Lost autotrack for 10 sec; some telemetry
	1	5	16:59:51	08:10					−114	On beacon; aided track; some telemetry
24	3	14	05:25:55	01:40						No autotrack; intermittent lock
	2	15	06:59:12	—			06:59:12	02:30	−130	
	3	15	06:58:29	08:30						On transponder; possible side lobe
	2	16	08:32:41	08:30					−97 (max)	Some engineering and spacecraft telemetry; momentary lock only
	1	16	09:14:39	05:34			09:15:00	05:13	−116	Acquired beacon
	2	17	10:08:32	08:20			10:15:02	01:50	−95 (avg)	
	3	17	10:09:20	08:50			10:09:40	07:50	−70 (max)	Good telemetry
24	1	17	10:48:51	07:09			10:52:04	03:55	−94 (max)	Good telemetry
	2	18	11:44:42	05:10						
	3	18	11:45:00	03:21			11:45:20	03:01		Transponder acquired
	1	18	12:25:25	00:20	12:25:45	13:46	12:26:31	05:50	−117	Good telemetry
	1	19	14:00:31	00:20	14:00:51	08:19	14:01:01	08:09	−112	Telemetry in autosync 75% of time
	1	20			15:36:21	08:50	15:36:21	08:50	−110	Telemetry in autosync to 15:44:53
	5	20	15:38:00							10 telemetry points
	1	21	17:12:21		17:12:22	05:59	17:13:21	05:00	−117	
25	4	27	01:50:10						−140	Momentary locks; attempted autotrack too early
	4	28	03:25:00	03:25					−105	Angle errors too great for autotrack; TSE in sync, ¼ frame received
	4	29	05:06:27	00:10					−135	Beacon or transponder jumping 400 kc
	2	29								Prediction data late, unable to acquire
	3	29	05:38:50	01:40			05:39:00	01:10	−90	
	4	30	06:35:50	07:40			06:35:50	07:30		
	2	30	07:07:11	02:40			07:09:41	00:10		
	3	30	07:07:29	00:20			07:07:39	00:10		
			07:10:39	05:40			07:12:49	03:20		DSIF 3 gave antenna switchover command, transponder from high-gain to omni, OK; Chan 7.7 not in lock
25	1	31	07:49:21	00:10					−132	
	4	31	08:11:01	06:20					−115	Most of track on side lobe
	2	31	08:43:51	06:30			08:43:51	06:30	−90	
	3	31	08:47:49	04:30						DSIF 3 transmits antenna switchover command to sideband afterward; DSIF 3 transmits antenna switchover command, kept lock afterward; both commands effective

Table A-1. (Cont'd)

Date, Aug	Sta	Orbit	RF reception time, GMT						Signal, dbm	Remarks
			One-way		Two-way		Autotrack			
			In	Total	In	Total	In	Total		
	1	32	09:22:01	06:40			09:22:21	06:40	−94	Telemetry autosync held entire pass (B-10 bad phase)
	5	32	09:23:11	03:10			09:23:31	01:20	−130	HA jitter exceeded calibration limits
	2	32	10:17:41	09:40			10:17:51	08:00		
	3	32	10:17:59	01:00	10:18:59	07:20	10:18:49	07:30		Doppler multiplier out; changed transmitter frequency to bring multiplier in band
	1	33			10:57:33	06:40	10:58:21	05:20	−94	
	2	33	11:53:21	06:30			11:53:31	06:20	−95	Chan 7.7 not locked
	3	33	11:53:29	04:00	11:57:29	03:10	11:57:29			
	1	34	12:32:48	00:10	12:32:58	07:23	12:33:10	06:51	−96	
	1	35	14:08:11	08:20			14:08:21	08:00	−113	Manual sync telemetry
	5	35	14:09:59	01:25			14:09:59	01:25	−80	Out of lock, antenna rates too high; TSE out, no scientific data; engineering data Chan 2, intermittent lock
25	1	36	15:42:48	08:50			15:44:31	07:07	−100	Manual sync; telemetry
	5	36	15:44:00	00:10						Receiver lock but AGC indicated tracking on side lobe, no data
			15:44:57	00:30						
			15:45:51	01:30						
26	4	42	00:24:24	00:10					−112	Poor pass
	4	43	01:54:33	06:00			01:54:33	05:50	−68 (max)	Solid lock telemetry, except Chan 7.7; 2½ frames good TSE data; 1½ frames TSE data
	4	44	03:29:21	06:48			03:29:39	05:30	−70 (max)	Rate too high for antenna in short section, middle of track
	4	45	05:05:16	06:00						In lock 50% of time; very little autotrack
	3	45	05:36:19	00:10	05:36:29	07:40	05:36:59	07:00	−94	Chan 7.7, no lock
	2	45	05:36:45	05:37						On beacon
	4	46	06:39:14	07:00						Some lock; very little autotrack
	3	46	07:09:51	02:28	Pseudo 07:12:19	07:30	07:12:09	07:00	−80	Chan 7.7 no lock; pseudo two-way
	2	46	07:10:05	08:16			07:10:41	07:00	−80	Mode switch not in pseudo-error; hinge override command sent
	1	47	07:50:41	05:50			07:50:41	05:10	−85	
	5	47	07:51:41				07:51:41	00:30		
	3	47			Pseudo 08:44:59	05:30	08:46:19	04:00	−88	Chan 2, no lock; acquired in pseudo;
26	2	47			Pseudo 08:45:41	03:50			−84	Acquired in pseudo; hinge override command sent from DSIF 2
	1	48	09:26:04	05:31			09:27:01	02:10	−90 (max)	
	3	48	10:20:19	01:10	10:21:29	01:40	10:21:09	01:40	−100	
			10:23:09	05:26						From one-way to two-way and back to one-way; Chan 2 in and out; Chan 7.7 no lock
	2	48	10:20:51	02:00			10:21:11	06:30		
	1	49	11:00:20	06:18			11:00:46	05:35	−94 (max)	6 min telemetry good; 3-db peak-to-peak AM on last portion
	2	49	11:55:51	03:12			11:56:01	03:30		On transponder; Midwestern Recorder out
	3	49	11:56:24	00:45	11:57:09	04:54	11:57:09	04:40	−94	Sent roll override command; Chan 7.7 no lock

Table A-1. (Cont'd)

Date, Aug	Sta	Orbit	RF reception time, GMT						Signal, dbm	Remarks
			One-way		Two-way		Autotrack			
			In	Total	In	Total	In	Total		
	1	50	12:35:11	00:36	12:35:47	06:51	12:36:24	05:37	−71 (max)	Telemetry signal good
	1	51	14:09:40	08:15			14:10:14	07:37	−92 (max)	8 min telemetry received
	5	51	14:10:41	07:00			14:10:41	06:50		On transponder; TSE tape punch malfunctioned; no scientific data
	1	52	15:45:14	05:57			15:46:14	01:17	−104 (max)	Aided track most of pass; maximum signal due to ground reflections; telemetry in sync but signal condition poor
27	4	58	00:20:36	04:00			00:23:46	00:50	−80 (max)	Autotrack near end of pass; receiver in lock 70% of time; value of data doubtful
	4	59	01:53:15	05:20			01:53:25	03:30	−65 (est max)	Lost autotrack because antenna angular rates too high
27	4	60	03:29:02	04:40					−90 (max)	Manual track; angular rates too high for autotrack; calibration dish used on reference channel as experiment; telemetry data OK
	3	60	04:03:19							Momentary lock only; pass too low
	4	61	05:03:26	05:10			05:03:56	02:50	−110 (max)	Two frames TSE data; entire track on antenna side lobe, indicated by low maximum AGC
	2	61	05:35:41	04:30			05:36:01	04:10	−95	
	3	61	05:37:11	00:30	05:37:41	03:40	05:37:41	04:40	−97	Chan 7.7 no lock; 50% TSE function OK but discriminator channels had 1 pulse mod/sec on analog outputs
	4	62	(06:38:07)							Spectrum analyzer in lock for 3 sec; receiver never locked
	2	62	07:10:01	00:40					−125	1, 4 and 5 to concentrate on telemetry; DSIF 3 concentrate on track data; main lobe never acquired
	3	62	07:13:09	00:50					−120	Negligible tracking data; Chan 3 only lock in telemetry
	1	63	07:46:21	01:30			07:46:21	01:31	−116	Rates too high for DSIF 5
	3	63	08:41:41	08:50			08:41:51	08:10	−84	Only Chan 3 in lock
	2	63	08:41:41	08:00			08:42:01	07:40	−85	Midwestern out
	1	64	09:22:21	05:10			09:22:41	04:50	−116	Transponder on; beacon mod off; no telemetry data
	3	64	10:16:49	07:20			10:16:59	07:00	−94	Only Chan 1 in lock
	2	64	10:16:41	06:30			10:16:51	06:20	−88	DSIF 2 secured
27	1	65	10:56:41	05:40			10:57:11	04:50	−121	Transponder signal for 23 sec; Chan 1 and 3 lock for short time; 33 sec telemetry
	1	66	12:30:41	07:00			12:31:11	06:10	−120	Transponder on
										Beacon mod on
	1	67	14:04:41	07:10			14:05:21	05:50		Transponder on 14:08:35, off 14:08:50; beacon on 14:07:57, off 14:09:06;
	5	67	14:06:01	01:40			14:06:31	01:10	−130 (avg)	Went to point midway through pass and waited; high rates prevented acquiring main lobe
28	4	74	00:12:25	03:20					−130	No modulation on beacon; no transponder on spectrum analog; pass ahead of prediction; receiver lock intermittent
	4	75	01:44:26	03:20			01:44:26	02:50	−70 (max)	Modulation on beacon intermittent; no transponder signal; Mercury Scama voice circuit in operation

Table A-1. (Cont'd)

Date, Aug	Sta	Orbit	RF reception time, GMT						Signal, dbm	Remarks
			One-way		Two-way		Autotrack			
			In	Total	In	Total	In	Total		
	4	76	03:19:54	01:10			03:19:54	02:10	−80 (max)	Broader beamwidth seems to help early acquisition; transponder on spec analog only once in early pass
	3	76	03:54:00	01:20			03:54:00	01:20	−100	
	4	77	04:52:37							No transponder signal; beacon mod only once; Chan 1 only in lock; receiver intermittent lock
	3	77	05:25:39	05:10			05:25:39	05:10	−90	
28	1	78	06:02:41	05:30			06:03:01	04:50	−121	Out of lock to check receiver tuning
	4	78	06:27:28	01:00					−130	Beacon mod but no lock; no transponder signal, too low
	3	78	07:01:09	00:40					−125 (max)	Momentary lock Chan 1, all others out; no data
	1	79	07:35:51	05:50			07:36:21	05:20	−100 (max)	Constant sine-wave on wideband telemetry signal; Chan 3 out of lock when above received
	5	79	07:36:00						−117	Telemetry momentary lock only
	3	79	03:30:49	07:50			08:30:59	07:20	−92	Track predictions off 4½ min; Chan 1 in lock 7 min, others out
	1	80	09:11:31	04:20			09:12:01	03:10	−113	
	3	80	10:04:59	07:00			10:05:19	06:10	−95	Chan 1 in lock for complete mission; Chan 3 locked on tone from faulty VCO in receiver
	1	81	10:44:41	05:40			10:45:11	04:50	−113	Modulation present to 10:47:35
	1	82	12:18:11	06:40			12:18:21	05:40	−95 (max)	Tones on
	5	82	12:19:00							Tones off, etc.; 6-foot dish used
	1	83	13:52:11	06:10			13:52:51	04:50	−121	Chan 1 and 3 in lock 1 min
	5	83	13:52:41	02:40			13:53:41	01:30	−117 (max)	
	4	89	23:53:36						−110 (max)	Lock momentarily on transponder due to doppler shift; parallel dish configuration was used
29	4	91	(01:29:44)							No signal; parallel dishes still used
	4	92	(03:02:54)							No signal; small dish only; in manual
	3	92	(03:27:31)							No signal
	4	93	(04:35:41)							No signal; parallel dishes
	3	93	(05:01:37)							No signal
	4	94	(06:10:02)							No signal; DSIF 4 secured
	1	94	(06:25:00)							No signal
	3	94	(06:33:41)							No signal; DSIF 3 secured
	1	95	(08:00:00)							No signal; DSIF 1 secured

II. *RANGER* 2 OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-8–A-14) for the *Ranger* 2 space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary in the form of edited station logs. Translations of the code names used in Table A-2 to identify the space communication stations of the DSIF are contained in Section I of this appendix.

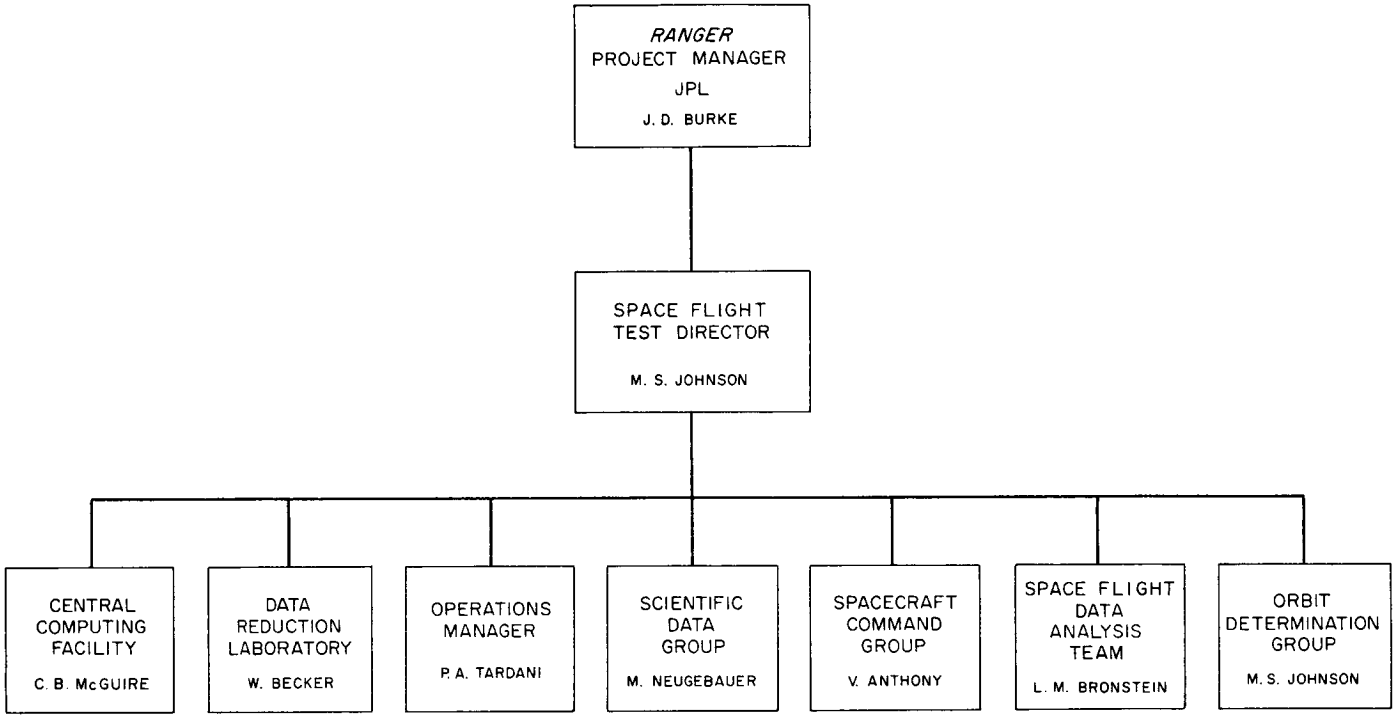
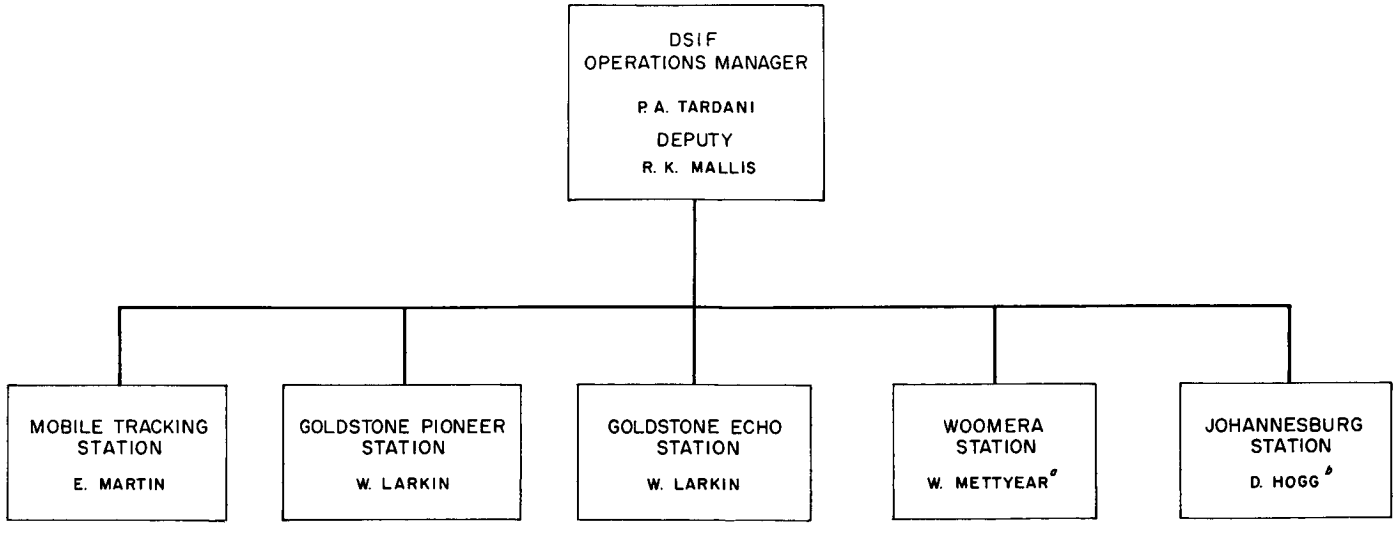


Fig. A-8. Space flight operations organization for *Ranger* 2



[a] WEAPONS RESEARCH ESTABLISHMENT OF THE DEPARTMENT OF SUPPLY, COMMONWEALTH OF AUSTRALIA

[b] NATIONAL INSTITUTE OF TELECOMMUNICATIONS RESEARCH, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF THE REPUBLIC OF SOUTH AFRICA

Fig. A-9. DSIF operations organization for *Ranger* 2

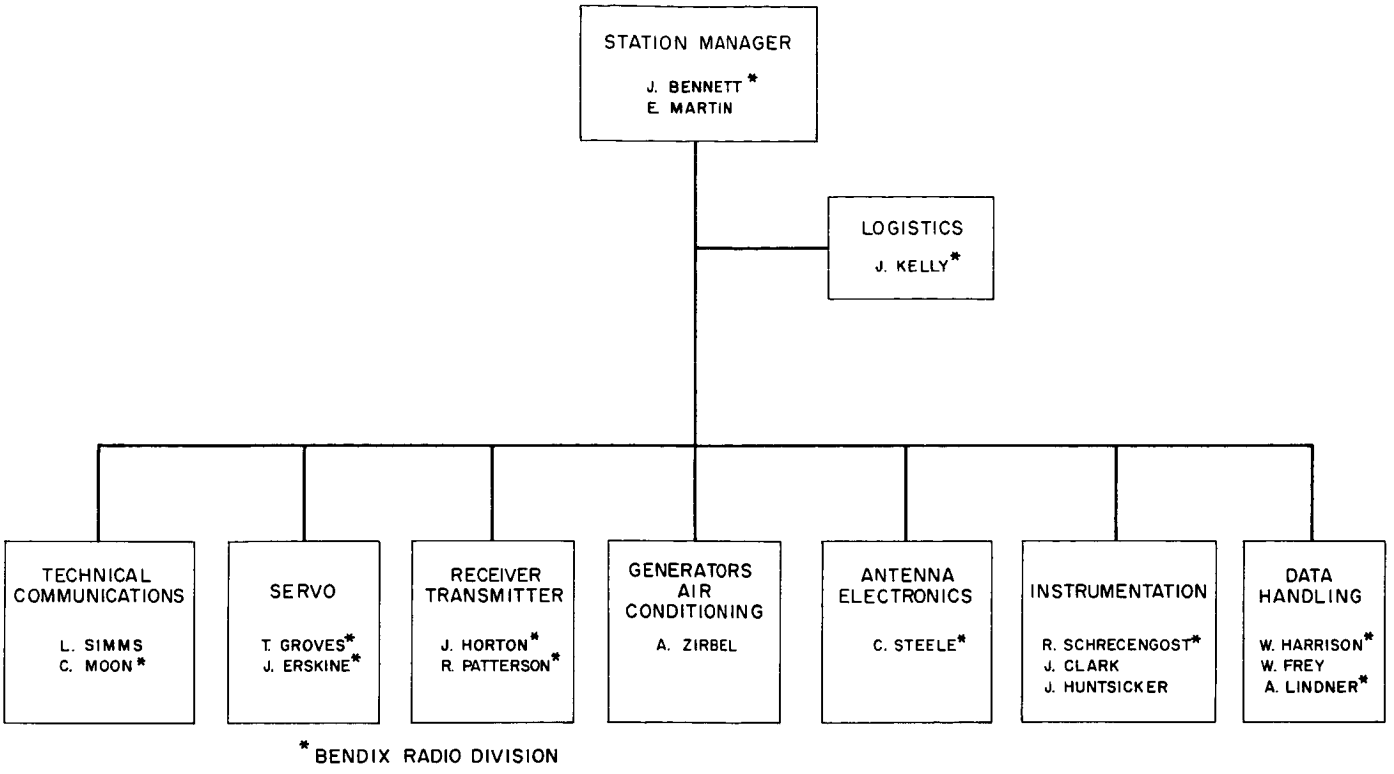


Fig. A-10. Mobile Tracking Station organization for *Ranger 2*

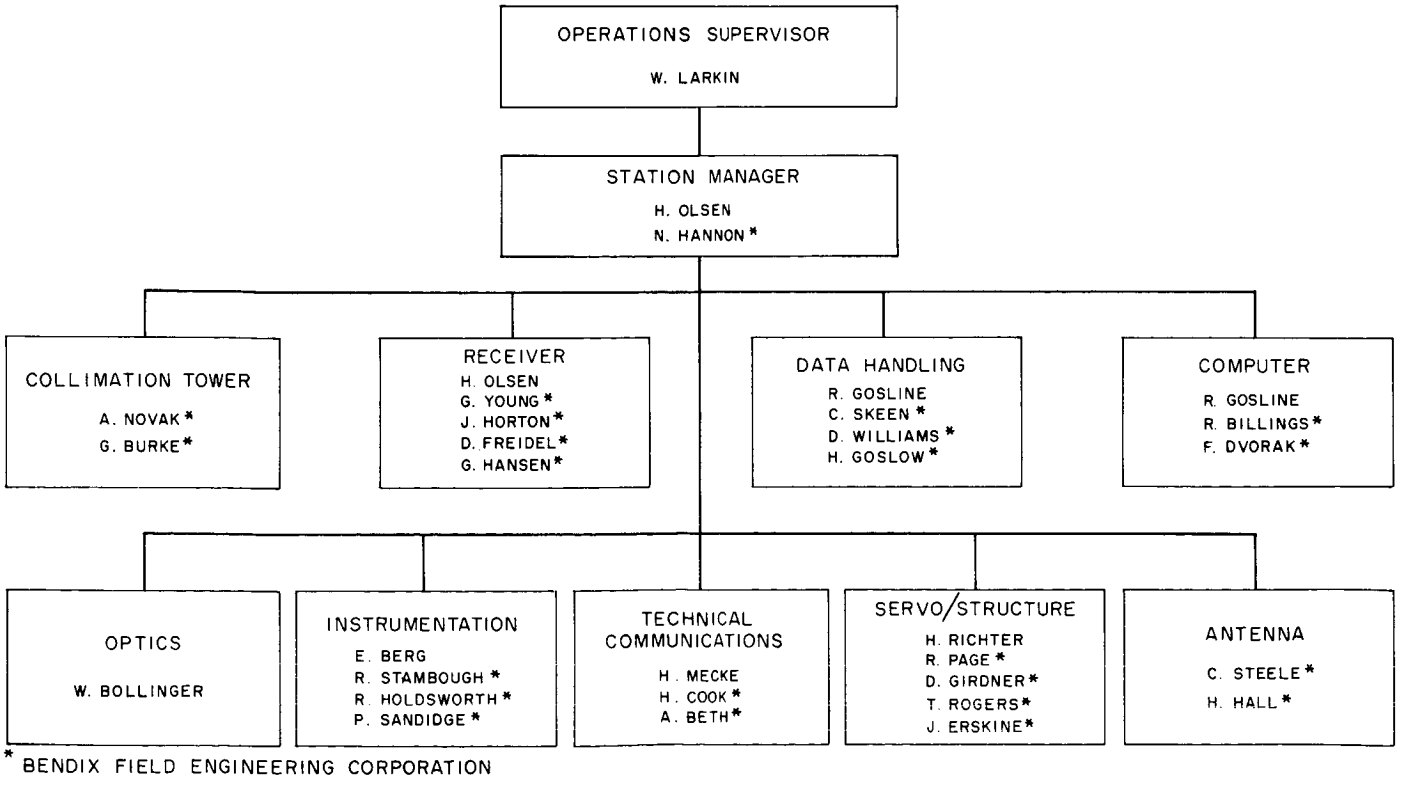


Fig. A-11. Goldstone Pioneer Station organization for *Ranger 2*

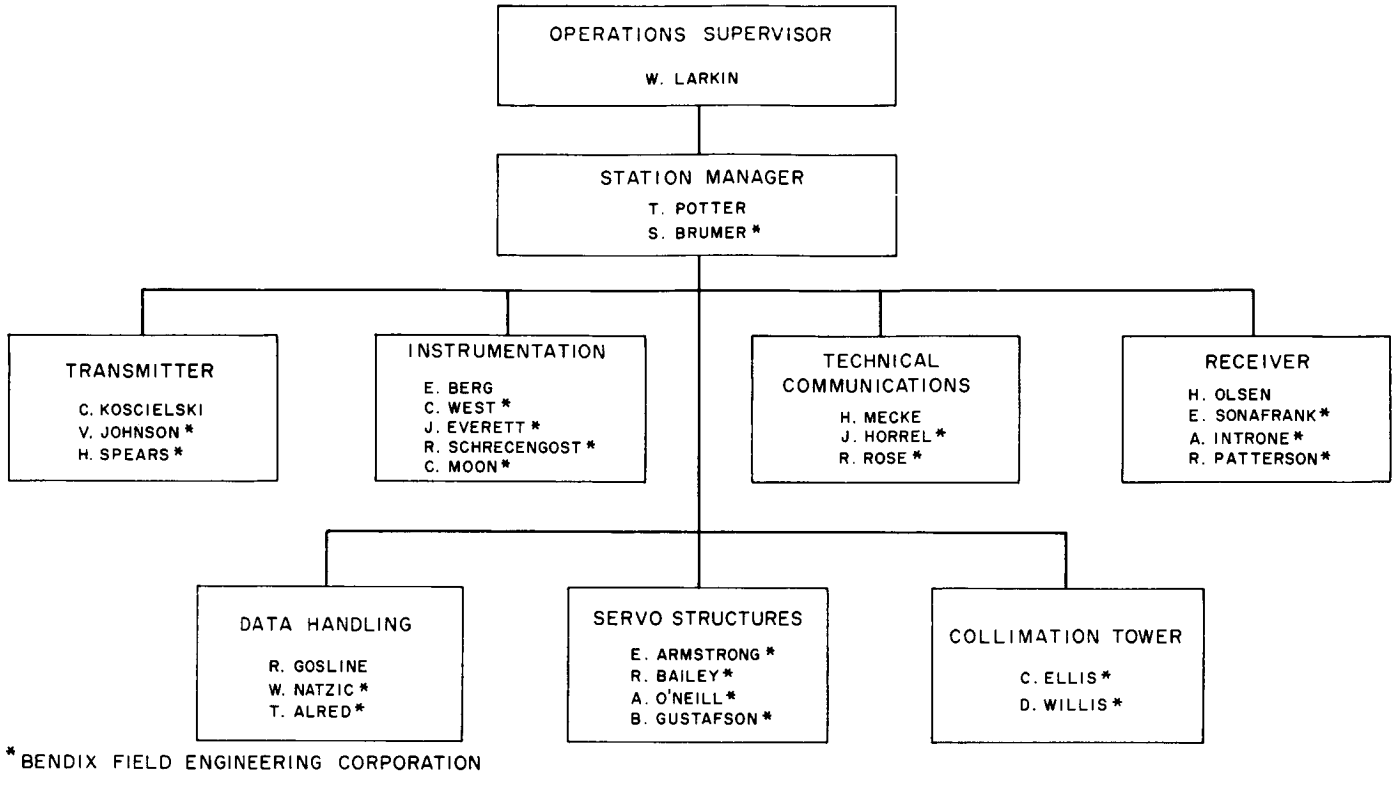


Fig. A-12. Goldstone Echo Station organization for *Ranger 2*

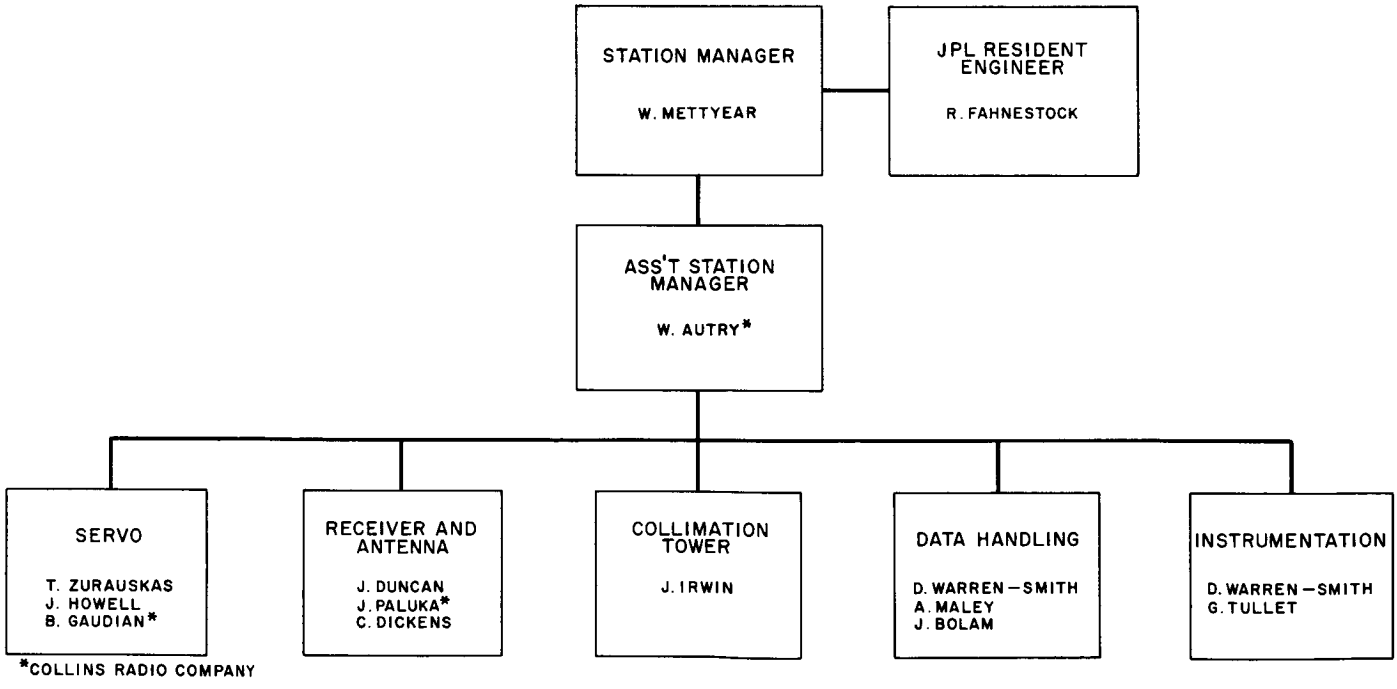


Fig. A-13. Woomera Station organization for *Ranger 2*

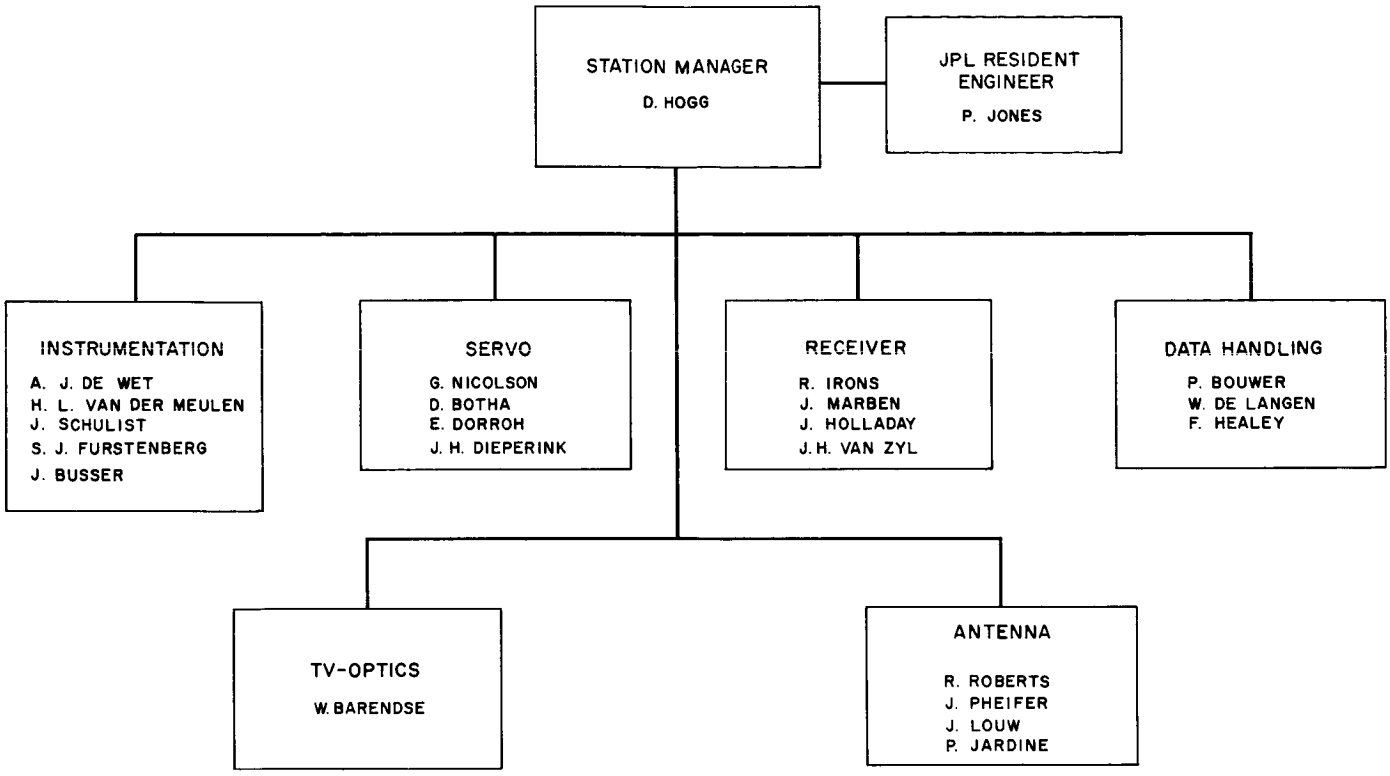


Fig. A-14. Johannesburg Station organization for *Ranger 2*

Table A-2. *Ranger 2* tracking operations summary

Date, Nov	Station	Orbit	RF reception time, GMT						Signal, dbm	Remarks
			One-way		Two-way		Autotrack			
			In	Out	In	Out	In	Out		
18	1	1	08:44:38	08:48:30	08:48:30	08:50:56	08:44:45	08:50:56	−114 to −121	Tracked the transponder; began recording telemetry at 08:48:30 and continued until loss of lock at 08:50:56; data were transmitted to JPL in near real time.
	5	1	08:46:42	08:46:56						Tracked the beacon; obtained only momentary lock; auto track was not achieved and no useful data were obtained.
	2	1	09:40:11	09:40:21					−130 (max)	Attempted to track the transponder; the antenna was tracking with a side lobe and when an attempt was made to acquire with the main lobe the signal was lost and RF lock could not be attained again.
	3	1	09:38:56	09:44:46			09:39:23	09:44:46	−125	Tracked the beacon signal using the 6-ft dish; intermittent RF locks were obtained during the period indicated; because of problems in the data handling equipment the data condition code did not indicate RF lock or auto track; no telemetry data were obtained.
	1	2	10:17:08	10:17:21	10:17:21	10:23:39	10:17:41	10:23:01	−114	Tracked the transponder; obtained and transmitted telemetry data in near real time to JPL; obtained good tracking data.

Table A-2. (Cont'd)

Date, Nov	Station	Orbit	RF reception time, GMT						Signal, dbm	Remarks
			One-way		Two-way		Autotrack			
			In	Out	In	Out	In	Out		
	5	2								Unable to track because the pass was behind the polar mask.
	3	2	11:13:54 11:14:38 11:15:21 11:15:43	11:14:05 11:14:42 11:15:27 11:16:11						Tracked the beacon with the servo system in the aided track mode; no useful data were obtained.
	2	2								The spacecraft passed low on the horizon and according to predictions would be visible for 1 min, 30 sec; a momentary RF lock was obtained at 11:14:17.
	1	3	11:50:25	11:50:51	11:50:51	11:56:53	11:50:51	11:56:10	−115	Tracked the transponder signal; transmitted tracking and telemetry data to JPL.
	5	3								Pass not visible to the station.
	1	4	13:22:50	13:23:16	13:23:16	13:26:48	13:23:18	13:26:41	−105	Tracked the transponder signal and transmitted tracking and telemetry data to JPL.
	5	4	13:23:41	13:26:32			13:25:02	13:25:52	−90 −85 −130	Tracked the beacon signal; lost lock during the track because of the high angular rates required; tracking data and engineering and scientific telemetry data were transmitted to JPL after the pass; the station was secured after this pass since Orbit 5 would not be visible.
	1	5	14:56:29	14:56:47	14:56:47	15:01:17	14:56:51	14:59:21	−112	Tracked the transponder; transmitted tracking data in real time to JPL; telemetry data were transmitted to JPL after the tracking period.
	4	11								Began searching for signal at 23:10, 10 min before predicted acquisition time; continued searching for beacon signal until 10 min after predicted loss of signal; negative results; the 6-ft dish was in parallel with the reference channel.
19	4	12								Began searching at 00:34; the 6-ft dish was in parallel with the reference channel; searched until 01:00 with negative results.
	4	13								Used wide-beam dipole and searched from 02:00 to 02:32; listened at 960.1 Mc but heard no signal.
	4	14								Listened at 960 Mc using the wide-beam dipole; searched from 03:30 to 04:05; no signals were heard.
	2, 3	15								Conducted search for beacon and transponder frequencies; no results; all stations secured.

III. *RANGER 3* OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-15–A-21) for the *Ranger 3* space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary in the form of edited station logs. Translations of the code names used in Table A-3 to identify the space communication stations of the DSIF are contained in Section I of this appendix. Table A-3 also contains special coding for the spacecraft telemetry modes (TM) and the ground station modes (GM) of operation as follows:

Telemetry modes

TM-I – Launch to midcourse maneuver flight period. Transmission of all data but midcourse maneuver parameters and preimpact telemetry.

TM-II – Midcourse maneuver flight period. Same data transmission as TM-I, except midcourse maneuver parameters are substituted for a portion of the engineering telemetry and the command decoder and gamma ray telemetry.

TM-III – Postmidcourse to end of terminal maneuver flight period. Same data transmission at TM-I but boom for gamma ray experiment is extended.

TM-IV – Postterminal maneuver to impact flight period. Transmission of vidicon picture, gamma ray intensity, and altimeter echo strength.

TM-V – Postimpact flight period. Transmission of analog output of seismometer amplifier.

Ground station modes

GM-1 – Receiver tracking the transponder signal (960.05 Mc) in the two-way doppler mode.

GM-2 – Receiver tracking the transponder signal (960.05 Mc) in the one-way doppler mode.

GM-3 – Receiver tracking the transponder signal (960.05 Mc) in the pseudo two-way doppler mode.

GM-4 – Receiver tracking the capsule beacon signal (960.05 Mc) in the one-way doppler mode.

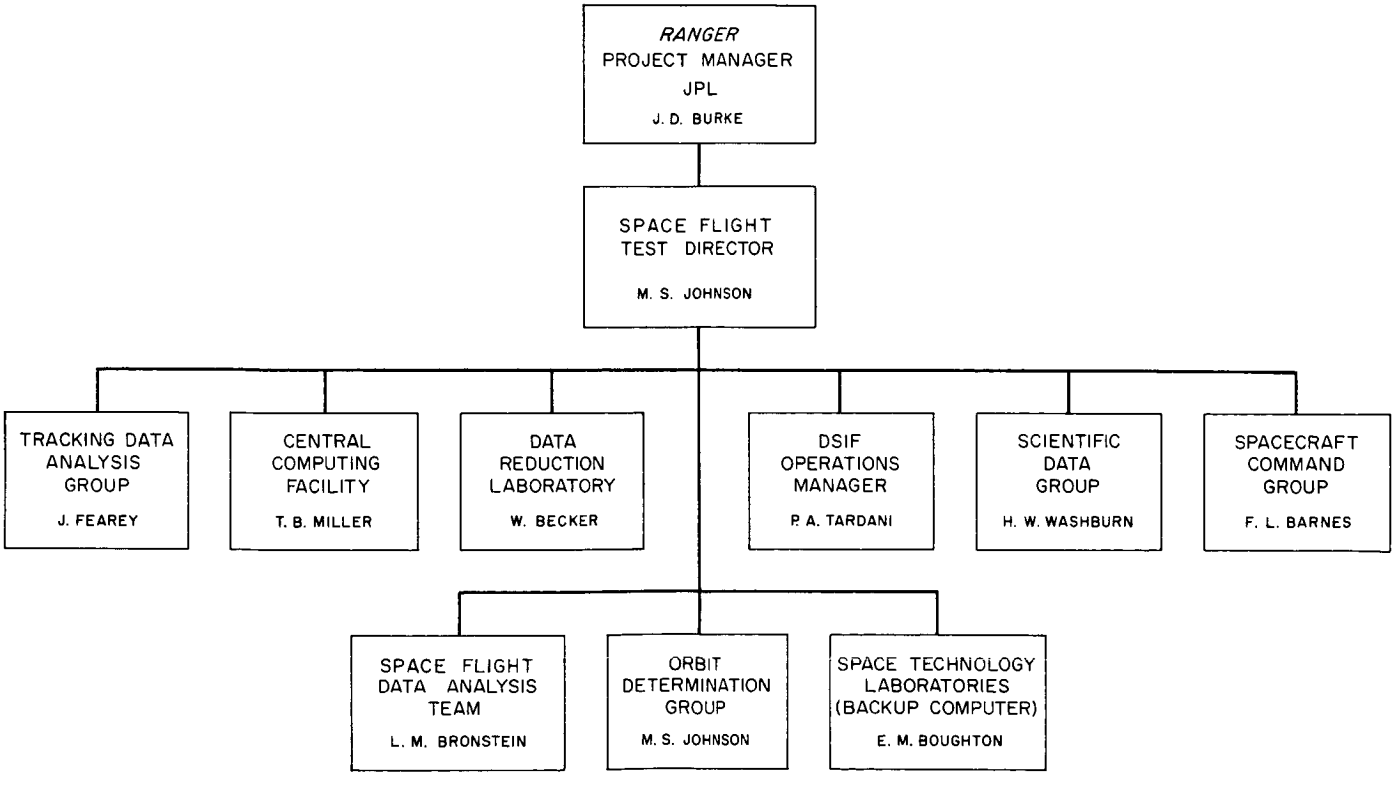
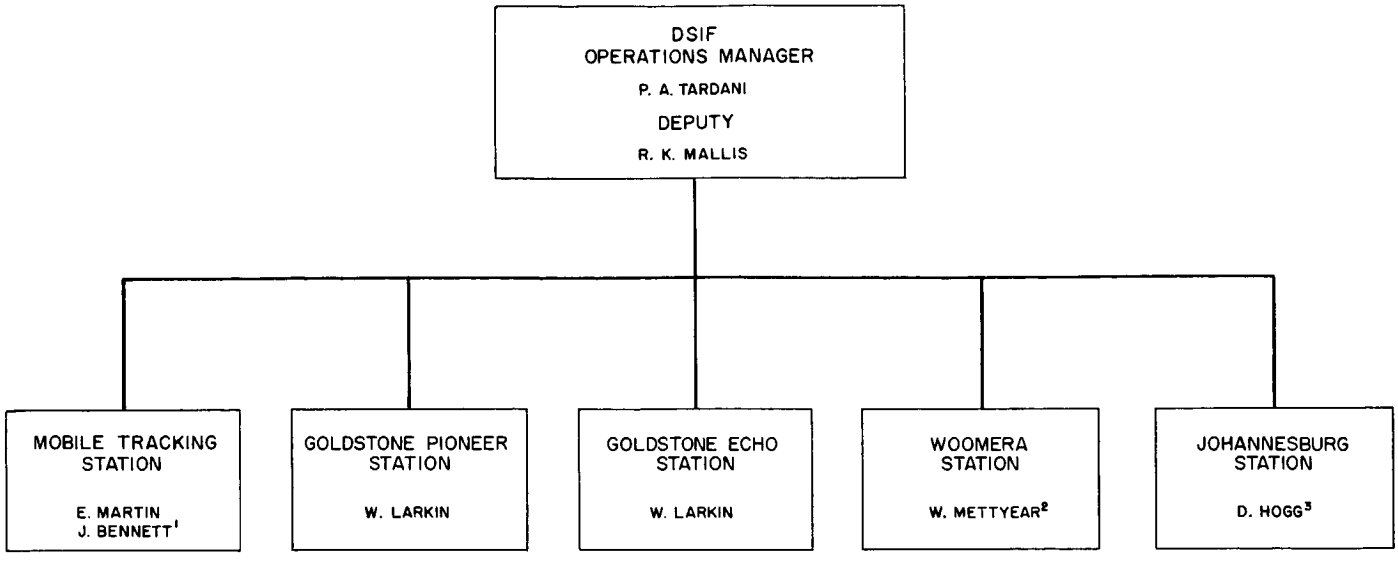
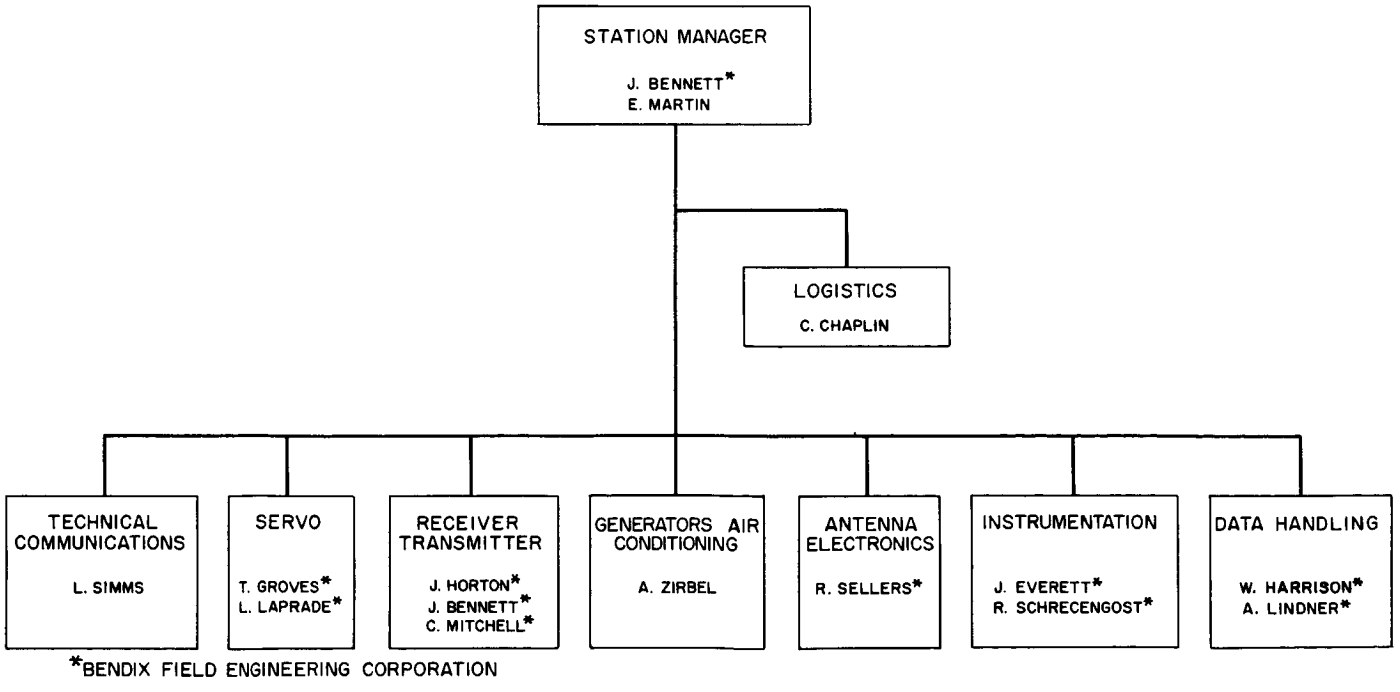


Fig. A-15. Space flight operations organization for *Ranger 3*



[1] BENDIX FIELD ENGINEERING CORPORATION
[2] WEAPONS RESEARCH ESTABLISHMENT OF THE DEPARTMENT OF SUPPLY, COMMONWEALTH OF AUSTRALIA
[3] NATIONAL INSTITUTE OF TELECOMMUNICATIONS RESEARCH, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF THE REPUBLIC OF SOUTH AFRICA

Fig. A-16. DSIF operations organization for *Ranger 3*



*BENDIX FIELD ENGINEERING CORPORATION

Fig. A-17. Mobile Tracking Station organization for *Ranger 3*

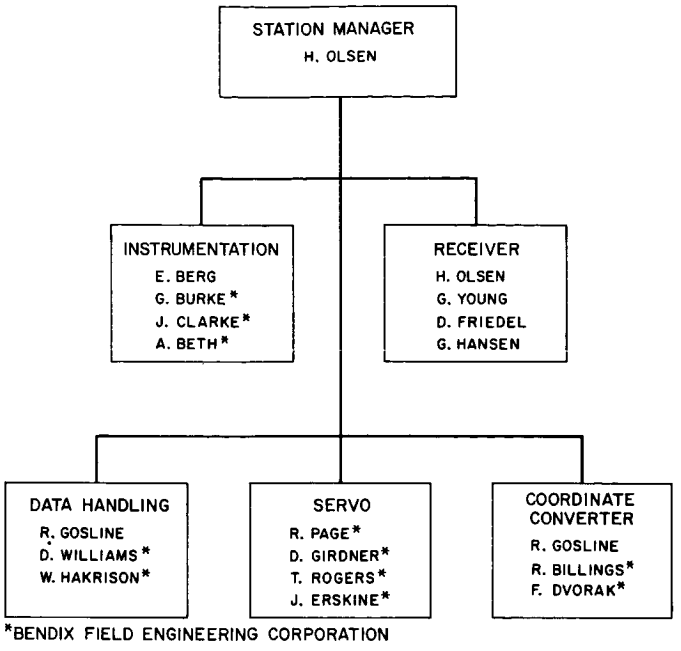


Fig. A-18. Goldstone Pioneer Station organization for *Ranger 3*

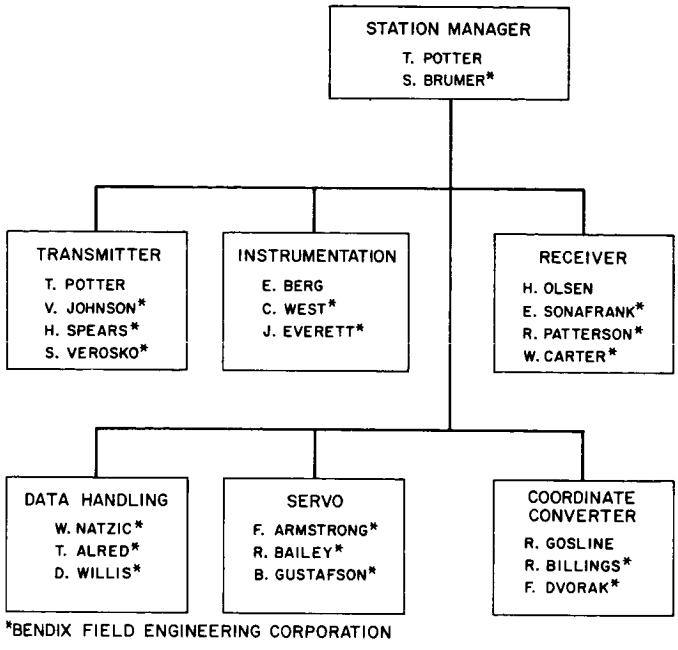


Fig. A-20. Goldstone Echo Station organization for *Ranger 3*

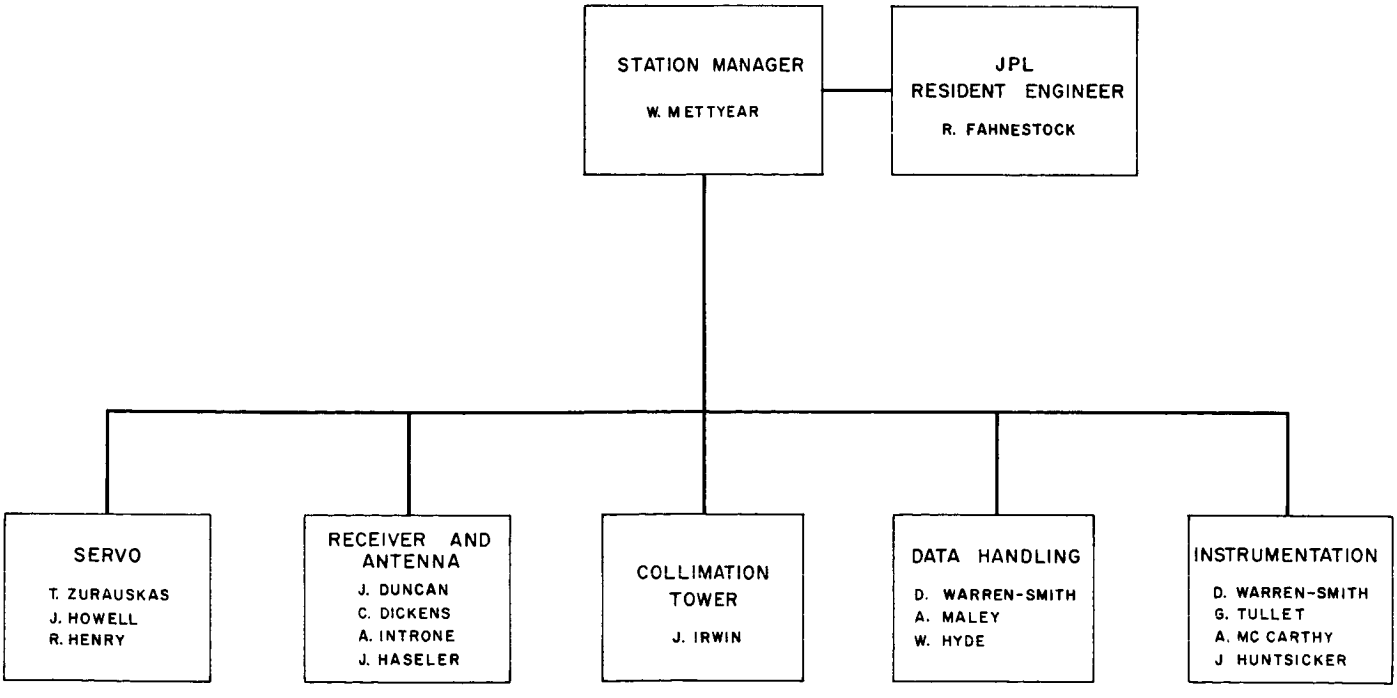


Fig. A-19. Woomera Station organization for *Ranger 3*

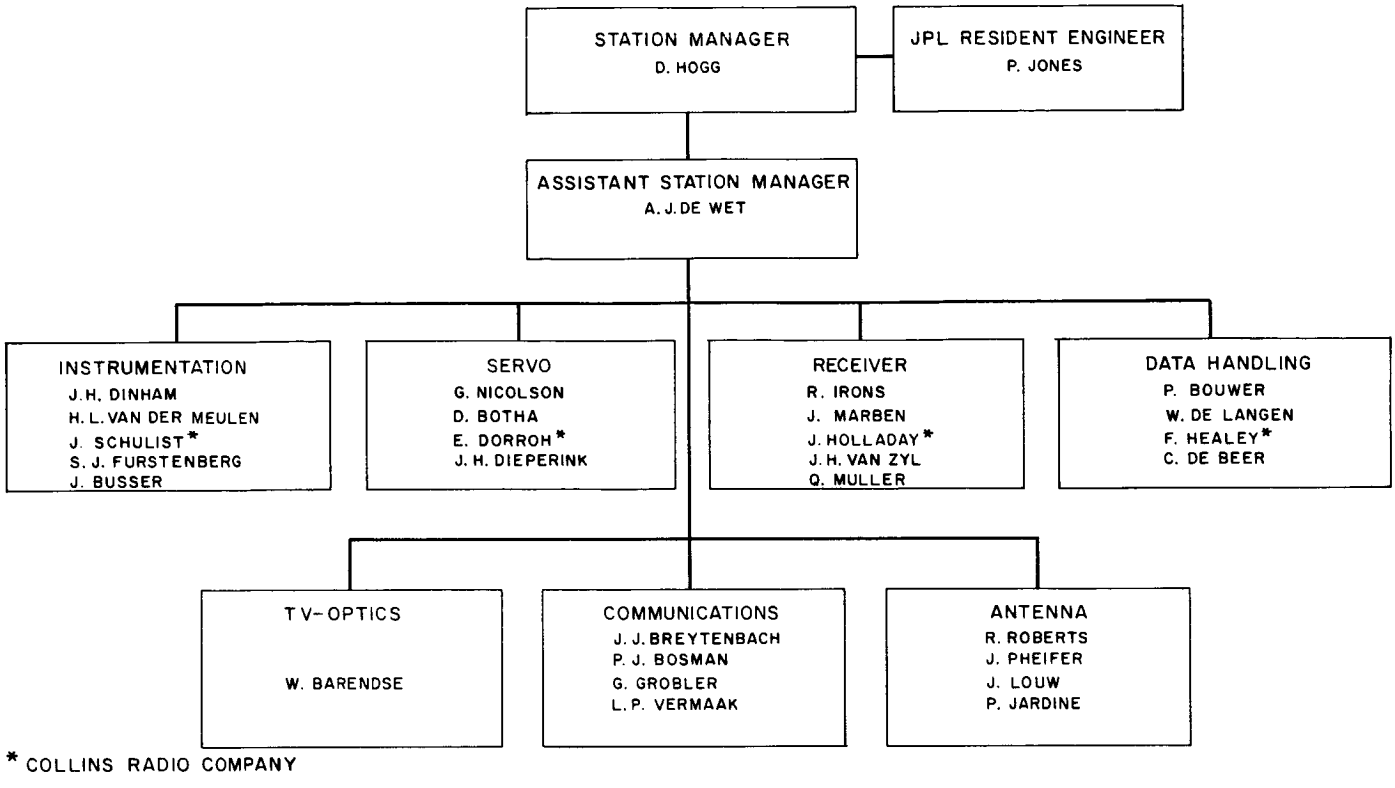


Fig. A-21. Johannesburg Station organization for *Ranger 3*

Table A-3. *Ranger* 3 tracking operations summary

STATION: DSIF 1
VIEW PERIOD: 26/2055 to 27/1010

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2056 to 2105 TM-1 GM-1	-114	205523	Initial acquisition at 205523.
	-114	210000	Autotrack at 205655 and telemetry in lock at 205715.
	-126	210337	
2107 to 0020, TM-1, GM-1	-139	212325	The receiver lost lock at 210530. Reacquisition was
	-141	214330	accomplished in a one-way doppler mode at 210714.
	-144	220327	Two-way doppler mode achieved at 210732. Telem-
	-144	222330	etry was in lock at 210903. Transmitter radiating
	-146	224329	43.8 dbm. Telemetry went out of lock at 215000. An
	-146.5	230333	error occurred in the data condition code between
	-146.5	232335	221950 and 223051. Data recorded during that time
	-148.5	235000	was indicated as no good when in actuality it was all
	-148	27/0003	right. At 27/002000 the transmitter was turned off because of increasing signal degradation.
0030 to 0844, TM-1, GM-2	-150	004314	Telemetry still out of lock after reacquisition. As
	-150	010325	the signal level approached receiver threshold the
	-150	020326	data condition began indicating that the receiver was
	-150.5	022310	out-of-lock at 055900 lock was lost momentarily and
	-151	024320	reacquired at 060010. At 075915 lock was again lost
	-152	030326	and reacquired at 080015. At 081230 the servo system
	-152.5	032321	was switched from the autotrack to the aided mode.
	-152.5	042316	Prior to this lock was lost for two brief periods,
	-153	044308	080711 to 081000, and 081050 to 081140. Lost lock at
	-153.5	052338	084410.
	-153	070400	
	-154	074300	
	-155	082300	
	-155	084410	
0852 to 1010 TM-1, GM-3	-154	090900	Reacquired at 085220 after Goldstone was in a two-
			way condition. At 091633 the spacecraft transponder
			was switched to high-gain antenna the resultant im-
			proved signal strength (-106 dbm) allowed the telem-
			etry discriminators to be relocked at 091800. The

Table A-3. (Cont'd)

STATION: DSIF 1

VIEW PERIOD: 26/2055 to 27/1010

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0852 to 1010 TM-I, GM-3			stored commands transmitted to the spacecraft from Goldstone were read from the telemetry analog between 092351 and 092559.
	-123	091835	
	-123	092400	
		101000	Receiver out of lock.

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 26/2056 to 27/0956

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2059 to 2110, TM-I, GM-3	-104	205639	Telemetry data in lock, event blips observed on telemetry analog presentation. Servo bandwidth set to 0.25 cps. The signal was first acquired using the acquisition aid antenna. The switchover to the large antenna was accomplished smoothly at 205930. The parametric amplifier is not being used because its characteristics had changed between turn-off and turn-on prior to the mission and sufficient time was not available to check the parametric preamplifier.
	-104	210200	
2111 to 2325, TM-I, GM-3	-123	212300	Receiver lock was lost and the servo system switched to aided track at 211015. The system was switched back to autotrack at 211039 and telemetry channels relocked at 21110. There was a failure of the reproduce head of Channel 1 of recorder A. Channel 1 was then paralleled with Channel 2. At 232500 the station went out of lock to put the parametric preamplifier back in operation.
	-124	213900	
	-127	215902	
	-128	221620	
	-130.5	224100	
2341 to 27/0020 TM-I, GM-3	-131.5	234125	The station was back in lock at 234125 and all telemetry channels were in lock at 234250. The parametric preamplifier was operating at 233540. Operation was achieved by retuning the preamp and setting the gain to 17.5 db. (Adjustment for the nominal gain, 20 db, could not have been made as quickly.)
	-130	27/0001	
0020 to 0844, TM-I, GM-2	-132.5	002400	Signal reacquired with no trouble after turn-off of the Mobile Station transmitter. Telemetry signals were relocked without trouble.
	-132.5	005800	Receiver out of lock from 005404 to 005703. Telemetry signals relocked after reacquisition. System noise temperature was found to be 205°K at 012130. At 0203 the system noise temperature was reported as 210°K. Some problem was experienced with garbling of the teletype-encoded telemetry data. This was caused by the letter figure shift on the punch. From 083410 to 084140 the antenna was locked in declination
	-132.5	015803	
	-132.5	030130	
	-133.5	032230	
	-133.5	042400	
	-134	044450	
	-134.5	054300	
	-135.0	063930	

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 26/2056 to 27/0956

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0020 to 0844, TM-1, GM-2	-134	070000	in preparation for Goldstone acquisition.
	-134.5	072100	
	-135	074200	
	-135.5	080200	
	-135.5	084106	
0846 to 0956, TM-1, GM-3	-135.5	090100	Receiver was in and out of lock from 084359 to 084547. Receiver and all telemetry in lock after 084547. After Goldstone commanded the spacecraft transponder to the high-gain antenna the signal strength increased to -106 dbm. Telemetry still in lock.
	-106	091613	
	-132	094400	Antenna into prelimits.
		095624	Receiver out of lock.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 26/2130 to 27/0142

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2130 to 0020, TM-I, GM-3		212950	RF lock on the transponder signal.
	-120	214000	Signal steady all telemetry discriminations in lock.
	-123	220900	
	-127	230900	
		002020	Out of lock when DSIF-1 turned off transmitter.
0020 to 0142, TM-I, GM-2		002030	Back in lock.
	-126	002200	All telemetry discriminations in lock.
	-136	010900	
	-131	014100	
		014230	End of autotrack. Antenna into prelimit.
		014700	Telemetry out of lock.
	-160	015900	Receiver out of lock.

Table A-3. (Cont'd)

STATION: DSIF 2 & 3
VIEW PERIOD: 27/0838 to 27/1837

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
	-146 (E)	083800	Echo Station receiver in lock.
(E) 0846 to 1000, TM-I, GM-1		084600	Echo Station establishes two-way lock. Telemetry good.
		085600	Echo station antenna in autotrack mode.
(E) 0846 to 1000, TM-I, GM-1 / (P) 0902 to 1000, TM-I, GM-3	-137 (P)	090200	Spacecraft above horizon at Pioneer Station. Receiver in lock.
		091500	Echo Station initiates antenna switchover command.
	-112 (E)	091603	
	-106 (P)	092000	
		092100	Clear command transmitted.
		092200	Clear command transmitted.
		092303	Roll duration transmitted.
		092403	Pitch duration transmitted.
		092503	Velocity increment transmitted.
		095500	Antenna switchover command transmitted.
	-131 (P)	095700	
	-144 (E)	095810	
(E) 1000 to 1016, TM-II, GM-1 / (P) 1000 to 1018, TM-II, GM-3		100000	Midcourse maneuver initiate command transmitted.
	-145 (E)	100123	
		100128	Confirmation of change in telemetry mode.
		100740	Because of low signal Pioneer Station telemetry is being recorded at the Echo Station.
	-148 (E)	101322	
	-137 (P) -154 (E)	101400	Signal level dropping.
		101555	Echo Station receiver out of lock. Both servosystems to aided track.
(E) 1000 to 1016, TM-II, GM-1	-152 (P)	101700	
		101831	Out of lock at the Pioneer Station.

Table A-3. (Cont'd)

STATION: DSIF 2 & 3
VIEW PERIOD: 27/0838 to 27/1837

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1030 to 1837, TM-III, GM-1		101912	One-way RF lock at the Pioneer Station. Signal level fluctuating about -160 dbm.
(P) 1019 to 1150 TM-III, GM-3	-153 (E)	102950	Receiver back in lock at the Echo Station.
	-151 (E)	103044	Three telemetry channels in lock at the Echo Station.
		103400	Signal strength increasing.
	-139 (P)	103900	
		104000	Telemetry shows telemetry mode is now TM-III.
	-147 (E)	104312	
	-145 (E)	110000	
		113700	The antenna switchover command was transmitted and the spacecraft responded by switching the transponder from the omniantenna to the high-gain antenna. After the command transmission the Echo Station receiver went out of lock briefly but was relocked immediately at a signal strength of -112 dbm. No trouble was experienced in locking up the telemetry discriminators.
	-104 (P) -112 (E)	113902	
(P) 1150 to 1311, TM-V, GM-4		115000	The Pioneer Station began searching for the capsule transmission at 960.15 Mc/s. The Echo Station continued tracking the transponder and the Pioneer Station switched to the slave mode to stay pointed at the spacecraft.
		115243	RF lock at -150 dbm on capsule frequency.
	-150 (P)	122500	Since there was some question as to whether the Pioneer Station had acquired the capsule signal, several checks were made and capsule tracking confirmed.
	-112 (E)	124049	

Table A-3. (Cont'd)

STATION: DSIF 2 & 3
VIEW PERIOD: 27/0838 to 27/1837

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1030 to 1837, TM-III, GM-1 (P) 1311 to 1837, TM-III, GM-3	-104 (P)	131100	The Pioneer Station reacquired the 960.05 Mc/s.
	-112 (E)	140800	transponder signal.
	-112 (E)	150300	
	-112 (E)	164800	
		172119	At the Echo Station a power surge caused by a diesel overload "kicked" the transmitter beam voltage off.
		172134	One-way acquisition accomplished at the Echo Station.
		172638	Receiver in two-way lock. Doppler number appears high.
		173103	Two-way lock reestablished after intentionally losing lock in an attempt to correct doppler number.
		173217	All Echo Station telemetry channels in lock.
		180044	After reacquisition the doppler frequency was still 300 cps higher than before the power surge. To correct this the transmitter was intentionally turned off and two-way acquisition repeated.
	-113 (E) -105 (P)	180302	Two-way lock reestablished at the Echo Station. From 172119 until this time the Pioneer Station had difficulty maintaining lock because of loss of lock by DSIF-3 during doppler number verification attempts.
	-143 (P)	183655	Tracking was terminated when the spacecraft set below the horizon.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 27/1439 to 28/0250

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1439 to 1837, TM-III, GM-3		143920	Telemetry channels initially in lock but, in going through the pattern null, lock was lost.
		144053	Reacquisition and relocking of the telemetry channels completed.
	-105	150800	
	-104	162400	
		172200	Receiver out of lock because of Goldstone transmitter shut down.
		172500	Receiver back in lock.
		173000	Receiver out of lock when Goldstone shut off transmitter to reacquire the spacecraft.
		173400	Receiver back in lock.
	-104	174700	All telemetry channels still in lock.
		180000	Receiver out of lock momentarily as Goldstone shut off transmitter to reacquire spacecraft.
		180100	Receiver out of lock momentarily.
	-104	180400	All telemetry channels still in lock.
		183700	Receiver out of lock when the Goldstone transmitter went off the air.
1841 to 0250, TM-III, GM-2		184100	Receiver back in lock.
	-104	184400	All telemetry channels in lock.
	-104	194400	Signal level steady.
	-104	204400	
	-104	214000	Signal steady and all telemetry channels in lock.
	-103	223700	
	-103	235000	
	-103	010000	
	-104	014400	All telemetry still in lock.
	-140	024600	
		025030	Tracking terminated when spacecraft passed below the station horizon.

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 27/2208 - 28/1023

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2208 to 0444, TM III, GM-2	-137	220842	Transponder signal acquired.
	-110	221642	Servosystem in autotrack mode and data good. All telemetry discriminators were in lock at 221005.
	-110	233600	Signal level steady. All telemetry channels in lock.
	-110	004130	
	-110	014540	All telemetry still in lock.
	-110	024000	
	-110	034000	All telemetry still in lock.
		040200	Engineering telemetry teletype encoder failed. Engineering telemetry will be recorded on the digital printer for subsequent manual transcription and transmission.
	-110	044400	
		044420	Receiver out of lock when Mobile Tracking Station (MTS) began attempting two-way acquisition.
0449 to 1023, TM III, GM-3		044920	Receiver in lock after MTS two-way acquisition.
	-111	054110	The telemetry teletype converter is still inoperative.
	-111	064500	All telemetry channels still in lock but telemetry teletype converter is still inoperative.
		065757	Telemetry discriminators taken out of lock to check channel with low signal.
		065906	Telemetry discriminators back in lock.
	-112	074200	Teletype converter operational except for slight garbling. Telemetry channels still in lock - data good.
		081130 to 081449	Receiver in and out of lock as MTS went to a one-way condition for testing purposes.
	-112.5	084200	Telemetry channels still in lock.
		084615	Receiver out of lock for Goldstone acquisition.
		084637	Receiver in lock.
		084800	Servosystem in autotrack.
	-111	094200	
		102032	Telemetry channels out of lock.
		102247	Receiver out of lock tracking terminated.

Table A-3. (Cont'd)

STATION: DSIF 1
VIEW PERIOD: 28/0423 to 28/1040

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(1)		042349	One-way lock on spacecraft transponder.
0447 to 0845, TM-III, GM-1	-134	044731	Two-way lock acquired. Transmitter radiating 43.6 dbm. Engineering telemetry data is not being recorded.
	-133	054313	
	-133	064300	
	-132	070340	
	-131	072315	
	-130	074331	
		081110	Out of lock to check two-way condition.
		081257	Back in lock.
	-131	084334	
		084500	Transmitter off.
		084505	Out of lock. Goldstone attempting two-way acquisition.
0849 to 1040 TM-III GM-2		084909	In pseudo two-way lock after transponder acquired signal from Goldstone transmitter.
	-129	090319	
	-130	100300	
	-154	104012	Signal level slowly decreased until loss of lock at this time.
			Tracking terminated.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 28/0839 to 28/1855

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		083803	Initial acquisition of signal at the Echo Station. Receiver in lock.
	-144 (E)	083845	
	-120 (E)	084126	
		084143	Echo Station servo system in aided mode, tracking using error meters.
	-120 (E)	084443	
		084504	Receiver out of lock.
		084653	Receiver in two-way lock.
	-120 (E)	084726	Telemetry channels locked up.
(E) 085011 to 1722, GM-1, TM-III		085011	Echo Station servo system in autotrack mode.
		090100	Pioneer Station antenna slaved to the Echo Station antenna. Previously the Pioneer antenna was manually following the computer commands in the aided mode.
		090300	Pioneer receiver in lock but spacecraft still below the horizon.
(P) 090505 to 151900, GM-3, TM-III		090505	
	-116 (P)	090707	
	-110 (P) -119 (E)	092200	All telemetry channels locked up.
	-119 (E)	100200	All telemetry channels locked up.
	-112 (P)	103806	
	-119 (E)	110200	
	-110 (P)	112505	
	-119 (E)	120200	
	-110 (P)	120958	
	-110 (P)	125500	
	-119 (E)	130230	All telemetry channels still locked up.
		130600	DSIF 3 switched the servo system to the aided track mode at 130417. Returned to the slave mode at 130533.
	-119 (E)	140024	
	-110 (P)	143100	
	-118 (E)	150654	
		151900	The Pioneer Station began searching for the capsule signal.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 28/0839 to 28/1855

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(P) 153800 to 154800, GM-4		153800	Capsule signal (960.15 Mc/s) in lock at -163 to -165 dbm.
	-113 (P)	154800	Pioneer Station resumes tracking the transponder signal (960.05 Mc/s).
(E) 085011 to 1722, GM-1, TM-III		154820	Terminal maneuver commands received at the Echo Station.
	-118 (E)	155015	
		162700	Begin transmitting commands to the spacecraft.
		162903	SC-4 transmitted.
		163007	SC-5 transmitted.
		163105	SC-6 transmitted.
		163254	Spacecraft telemetry indicates proper stored command reception by the spacecraft.
	-118 (E)	165950	All telemetry channels still in lock.
	-111 (P)	170400	
	-118 (E)	171423	
		172140	Terminal maneuver initiate command (RTC-6) transmission started.
(P) 154820 to 1722, GM-3, TM-III			
(E) 1722 to 1834, GM-1, TM-IV		172203	RTC-6 transmitted.
	-126 (E)	172228	Event blips on telemetry verify RTC-6 initiation. Telemetry mode advanced to TM IV. Signal level slowly decreasing.
	-155 (E)	173127	
	-147 (P)	173135	
	-148 (E)	174000	Both stations back in lock. The Echo Station lost lock at 173142 and the Pioneer Station lost lock at 173204. Reacquisition attempts were not immediately successful. The receiver was in two-way lock at the Echo Station at 173704. The Pioneer Station was in lock at 173918.
	-143 (P)		
		174700	Signal strength varying: -145 to -149 dbm at the Pioneer Station, -149 to -153 dbm at the Echo Station. The telemetry signals from the Pioneer Station are
(P) 1722 to 1834, GM-3, TM-IV			

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 28/0839 to 28/1855

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1722 to 1834, GM-1, TM-IV (P) 1722 to 1834, GM-3, TM-IV			being recorded at the Echo Station and all telemetry channels are in lock. The Echo Station antenna is tracking with its servo system in the aided track mode and the Pioneer Station is tracking by following the prediction data.
	-150 (E)	175138	Spacecraft telemetry mode indicated as TM-IV.
		175550	The telemetry being recorded is that from the Pioneer Station. Every 13 seconds a pulse is being observed on the telemetry.
		180517	RTC-3 transmitted to the spacecraft.
		180556	Verification received of switch of transponder signal from high-gain to omniantenna.
	-144 (P) -150 (E)	181000	No improvement in signal level.
		181105	RTC-3 transmitted again to switch the transponder signal from the omniantenna back to the high-gain antenna.
	-145 (P) -150 (E)	181246	No improvement in signal strength.
		181343	RTC-2 transmitted to the spacecraft to attempt hinge angle change.
	-145 (P) -150 (E)	181515	AGC at the Echo Station appears to be varying with the video level. No change in signal level.
		181700	RTC-3 transmitted to switch the transponder signal from the high-gain antenna back to the omniantenna.
	-143 (P) -150 (E)	182100	No improvement in signal level.
		182300	RTC-3 transmitted to switch the transponder signal from the omniantenna to the high-gain antenna.
	-145 (P) -150 (E)	182500	No signal strength improvement.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 28/0839 to 28/1855

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1834 to 1854, GM-1, TM-1	-150 (E)	183400	RTC-5 transmitted to advance the telemetry mode to TM-1.
(E) 1834 to 1855, GM-3, TM-1	-150 (E) -145 (P)	183750	RTC-1 initiated.
		184100	DSIF-3 antenna 5.1 degrees above its horizon.
	-139 (E) -135.5 (P)	184600	Signal strengths have been gradually increasing. Some limiting of telemetry signals was noticed at DSIF-3.
	-137 (P) -143 (E)	184657	Rapid signal fluctuations - gradually decreasing.
		185246	Servo system in brake at the Echo Station.
		185400	Receiver out of lock at the Echo Station.
(P) 1834 to 1855, GM-3, TM-1		185533	Receiver out of lock at the Pioneer Station.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 28/1501 to 29/0258

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1501 to 1721, GM-3, TM-III	-112	150100	
	-112	152500	All telemetry in solid lock. Signal level steady.
	-112	164300	Telemetry lock still good. Sample rate changed from once per 120 seconds to once per 60 seconds at 1600.
1721 to 1835, GM-3, TM-IV	-142	174000	Signal level steady, autotracking unsteady. Telemetry mode changed at 172139. All telemetry channels in lock except Channel 8. The receiver was out of lock between 173200 and 173440 and between 173838 and 173920. Pulses were observed on telemetry Channel B-2.
		180600	After 1748 the signal strength varied between -144 dbm and -145 dbm every ten seconds Channel B-2 repeatedly going out of lock.
1835 to 1855, GM-3, TM-I		183500	Spacecraft telemetry mode changed to TM-1.
	-138	183800	Signal strength increasing.
	-134	184300	Signal strength increasing.
		185200	Telemetry Channels B-2, B-20 and No. 1 fully in lock.
		185500	Receiver out of lock when the Goldstone Echo Station turned off its transmitter.
1857 to 2316, TM-I, GM-2	-140	185700	Receiver in one-way lock.
	-140	193900	Begin attempt to acquire the beacon signal.
		194500	Capsule signal strength approximately -160 dbm.
	-140	194900	Back in lock on spacecraft bus frequency. Telemetry Channels B-2, B-20 and No. 1 all in lock. Data sampling period changed to once per 120 seconds at 1943.
	-138	204000	Signal level varying slightly. All telemetry channels except Channel 8 are in lock. Autotrack is unsteady.
	-147	214000	Signal level varying. Telemetry Channels 1, B-2 and B-20 in lock.
		220000	Signal level varying from -128 dbm to -155 dbm. Telemetry Channels 1, B-2 and B-20.
		222500	Telemetry channels out of lock for one minute.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 28/1501 to 29/0258

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1857 to 2316, TM-I, GM-2	-147	230500	At 2301 a series of low signal going spikes appeared on the AGC line. Spike period was 14.4 seconds, amplitude was about 4 db with 10-second AGC time constant.
	-153	231000	AGC spikes disappeared at 2309 when AGC time constant changed to 300 seconds.
	-160	231500	
		231620	Receiver lost lock.
		232800	Signal reacquired.
		233000	Signal lost.
0015 to 0047, TM-V, GM-4	-150	001500	Capsule signal acquired at Net Control's request. Servo bandwidth 0.025 cps.
	-153	003000	
	-154	003500	Receiver AGC time constant changed to 300 seconds.
		004700	Lost capsule signal at -161 dbm.
0117 to 0258, GM-4, TM-V		011726	Capsule signal acquired. Telemetry Channel 2 locked up.
	-150	012200	Signal level steady.
	-147	012600	Signal level increasing.
	-149	014000	
	-154	014800	
	-156	020000	
	-161	015800	
	-162	020100	Receiver momentarily out of lock.
		020226	AGC time constant to 300 seconds.
	-162	021100	Receiver out of lock. Time constant set to 10 seconds.
		021600	Receiver in lock. Time constant to 300 seconds.
	-150	022500	
	-148	023000	
	-151	023600	
	-154	024000	
	-157	025000	
	-152	025500	
	-150	025800	End of track. Antenna at limits.

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 28/2230 to 29/1019

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2230 to 2303, GM-2, TM-I	-133	223044	Transponder signal acquired in one-way lock. Servo bandwidth 0.025 cps.
	-141	224834	Signal varying ±6 dbm. All telemetry channels in lock except Channel 8 which is in lock intermittently.
	-149	230200	Signal strength decreasing.
		230314	Receiver out of lock.
		231400	Still attempting reacquisition.
		235100	Still searching for signal. Receiver threshold was checked and found to be below -160 dbm.
		004600	Still searching for transponder signal.
		014200	Stop attempting to track transponder. Begin searching for capsule signal.
0236 to 0246, 0256 to 0310, 0326 to 0330, GM-4, TM-V	-151	023602	Capsule signal acquired. Signal level variable. Channel 2 in lock but near threshold.
	-158.5	024545	Receiver out of lock. Signal strength varying 7 db.
	-149.5	025620	Capsule signal reacquired.
	-148	030000	
	-152.5	030700	
	-157.5	031000	Receiver out of lock.
	-150.5	032600	Receiver in lock.
	-151.5	032920	
	-155	033015	
	-156	033035	Receiver out of lock. Capsule signal strength appears to be periodically varying between -148 dbm and -157 dbm. Period of cycle is approximately 20 minutes. The receiver is going out of lock at the lower signal levels.
		041410	Capsule signal not reacquired.
		045400	Still searching for capsule signal.
		045930	Transponder signals heard but could not lock up for more than a few seconds at a time.
		050945	Stopped transponder tracking attempts.
		051100	Attempting to track capsule signal.
		051935	Obtained momentary locks on the capsule signal. Return to transponder signal.

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 28/2230 to 29/1019

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0534 to 1019, GM-2, TM-I	-138	053418	By applying a fixed bias into the receiver loop the VCO frequency can be maintained during dropouts. Signals are now of sufficient quality to allow telemetry recording. The transponder frequency appears to be jumping in frequency as much as 5 cycles in a period of 15 seconds.
		062807	Tracking stopped. Antenna pointed at collimation tower for receiver checks.
		063714	Receiver checks satisfactory. Transponder tracking resumed.
	-139	064300	Signal level steady. Telemetry Channel 8 is out of lock. All other channels occasionally out of lock.
	-139	074900	All telemetry channels in lock. Signal level steady. Slow variation from -137 to -140 dbm. Large amount of phase jitter on the signal causes the receiver to drop lock for 0.5 to 1.0 second every 10 to 15 seconds. The 31-Mc VCO frequency seems to jump around for short periods. Variations of 4 to 5 cps were noted in a period of less than 5 seconds. The average frequency has been drifting slowly upward. At 0740 it was 20 cps higher than at 0640.
	-138.5	084630	All channels in lock except Channel 8. Receiver lock was lost several times between 0840 and 0845 and the VCO bias was readjusted. Receiver dropouts measured as occurring almost exactly every 13 seconds.
	-138.5	092218	Signal level steady. All telemetry channels except Channel 8 are in lock. Receiver momentarily out of lock several times.
	-138	094420	Telemetry channels occasionally dropping lock. Channel 8 not in lock.
		101400	Antenna into prelimits.
		101900	Receiver out of lock.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 29/0839 to 29/1908

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0839 to 1344, TM-I, GM-2	-147	083910	Receiver at Echo Station in one-way lock. At the Pioneer Station the parametric amplifier stopped oscillating for about fifteen minutes and then resumed operation. The pump klystron was suspect but because of the closeness of acquisition time no problem investigation was made.
	-141	083931	
		084550	The tracking filter of the receiver was modified to widen the reference loop bandwidth. This modification reduced the out-of-lock interval, caused by periodic carrier interruption, from 10 seconds to 0.5 seconds (the approximate length of the carrier interruption).
	-147	084804	Receiver losing lock every 14 or 15 seconds.
(P) 0910 to 1030, TM-I, GM-4		090100	One-way RF lock at the Pioneer Station. Solid lock could not be maintained because of strong AM pulling of the 31-Mc VCO every 15 seconds. Ten-second AGC time constant is being used. Echo Station using 300-second AGC time constant. Receiver at each station is going out of lock every 15 seconds.
	-147 (E) -140 (P)	093500	Pioneer Station has strong lock with modified tracking filters. The Echo Station is still losing lock periodically.
		093500	Telemetry signal from the Pioneer Station being transmitted over microwave to the Echo Station. Initial problem of staying in lock on this telemetry was cured by reducing the microwave video program amplifier output to eliminate telemetry input limiting.
		093540	Telemetry decommutator in sync.
	-140 (P)	093850	Transmitter on at Echo Station. Attempting two-way lock.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 29/0839 to 29/1908

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0839 to 1344, TM-I, GM-2	-147 (E)	094100	
		094300	Echo Station now recording on-site telemetry. Channel 8 is out of lock.
		095224	Transmitter off at the Echo Station. Two-way lock attempts unsuccessful. The Pioneer Station is tracking in the slave mode with servo bandwidth of 0.025 in hour angle and 0.10 in declination.
	-147 (E)	103000	Pioneer Station begins attempt to acquire the capsule signal. Up to this time periodic loss of lock was still occurring. Lock was being held by manually tuning the 31-Mc VCO and overriding the AM pulse which occurs every 13 seconds. Echo Station receiver is still dropping lock every 13 seconds. All telemetry channels are in lock except Channel 8.
		103600	An attempt, at the Echo Station, to lock up the Channel 8 discriminator using a 1% filter was unsuccessful. The Pioneer Station acquired capsule signal at 1034 but lost lock at 1036 with a signal level of -165 dbm.
	-147 (E) -165 (P)	110500	Pioneer Station still attempting to acquire the capsule signal. At 110000 the signal from the coordinate converter computer was not being received at the Pioneer Station. Pioneer Station antenna has been operated in the aided track mode since 104500. Several momentary RF locks have been obtained. Echo Station still experiencing periodic loss of lock. All telemetry channels in lock except Channel 8.
(P) 1112 to 1303, TM-I, GM-4	-167 (P)	111220	RF lock on the capsule signal at the Pioneer Station. The servo system is in aided track.
	-166 (P)	112350	At 1117 the servo system at the Pioneer Station was switched to the slave mode but erratic computer commands forced a return to aided track. Tracking filter switched from 60-cycle filter to a 20-cycle filter.
		112500	Channel 2 telemetry in lock 95% of the time.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 29/0839 to 29/1908

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0839 to 1344, TM-I, GM-2 / (P) 1112 to 1303, TM-I, GM-4		113700	Pioneer Station attempted slave track at 113300 but was unsuccessful and returned to aided track.
		115129	The parametric amplifier klystron pump failed and the capsule telemetry signal went out of lock. Receiver lock marginal. Because of AGC curve shift when parametric amplifier failed, signal level cannot be estimated.
	-147 (E)	122000	Signal level steady at the Echo Station. Still losing lock every 13 seconds.
		122830	Capsule signal out of lock.
		123400	Capsule signal back in lock. When parametric amplifier failed receiver threshold degraded by 3 db.
	-147 (E)	130051	Resume attempts for two-way lock. Transmitter radiating 200 watts.
		130158	Momentary two-way lock.
(E) 0839 to 1344, TM-I, GM-2		130300	Receiver at the Pioneer Station out of lock.
		133500	Pioneer Station could not reacquire lock in normal position. Attempt acquisition of the 960.05 Mc/s transponder signal.
		133651	Echo Station receiver out of lock for attempt to obtain two-way lock.
(E) 1344 to 1856, TM-I, GM-1		134423	Receiver in two-way lock at the Echo Station. Two-way acquisition was accomplished by manually tuning the transmitter VCO 1500 cps off the center frequency and then slowly sweeping it manually within the receiver VCO range. When the transmitter VCO was in its lower frequency range, the random noise spikes in the received signal were at a minimum.
	-147 (E)	134519	Echo Station receiver VCO had to be pulled 221 cps to get a good two-way lock.
	-140 (P)	134930	Pioneer Station in two-way lock using a 60-cycle tracking filter.
		135120	Telemetry good at Echo Station. Channel 8 in lock 30% of the time.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 29/0839 to 29/1908

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1344 to 1856, TM-I, GM-1		135410	Echo Station attempted to decommutate the telemetry data from the Pioneer Station but telemetry signal kept dropping lock. Return to on-station telemetry.
		135900	All telemetry channels in lock except Channel 8. Decommutator in sync.
(P) 1349 to 1605 TM-I, GM-3	-140 (P) -142 (E)	140200	
		143310	Transmitter VCO frequency being slowly increased. Pioneer Station having trouble maintaining doppler reference lock.
		143900	Transmitter VCO frequency still being increased slowly.
		145900	Echo Station now using Pioneer Station telemetry. The Pioneer Station obtained a consistent RF lock and it was noticed that the 31- Mc/s VCO cycle count disagreed with the Echo Station VCO cycle count. Trouble appears to be the times -15 multiplier in the doppler transmitter reference loop.
	-145 (E)	150100	Received signal unstable at both stations. Lowering Echo Station transmitter VCO frequency to stabilize signal.
		152000	The 13-second dropouts of the receiver stopped after two-way lock was established.
		152626	Echo Station recording on-station telemetry.
	-140 (P)	152800	Replacement of the times -15 multiplier at the Pioneer Station corrected the doppler count discrepancy.
		153000	To stop the receiver transients or signal drops, the transmitter VCO frequency is being decreased at the Echo Station.
		155350	Echo Station still recording on-station telemetry.
	-145 (E)	155510	Transmitter VCO frequency being decreased because transients are occurring in the received signal.
		160500	Pioneer Station stops tracking to attempt repair of parametric amplifier.
	-145 (E)	160600	

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 29/0839 to 29/1908

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1344 to 1856, TM-I, GM-1		161211	Transmitter VCO frequency again being decreased to eliminate random noise spikes in the received signal.
		161500	Adjusting transmitter VCO frequency did not eliminate the noise spikes.
		162934	Receiver at the Echo Station lost lock for about 20 seconds.
		163600	Parametric amplifier could not be repaired. Pioneer Station will attempt to track the capsule signal.
		164820	Using the Pioneer Station receiver with a 300-second AGC constant and a 20-cycle tracking filter the capsule signal could be detected but RF lock could not be obtained. Pioneer Station will attempt transponder acquisition.
	-145.5 (E)	165500	Telemetry Channels 2, 5 and 8 are in lock 95% of the time.
(P) 1657 to 1856, TM-I, GM-3	-141 (P)	165700	Pioneer Station in two-way lock using a 60-cycle tracking filter and 300-second AGC time constant. Servo in aided track mode.
		170040	Pioneer Station telemetry being recorded at the Echo Station. All telemetry channels in lock except Channel 8.
		171015	Pioneer Station out of lock.
		171036	Echo Station now recording on-station telemetry.
		171110	Pioneer Station back in lock.
	-139 (P)	171800	
		173300	Receiver lost lock for several 2- to 3-minute periods at the Echo Station. Lowering VCO static phase error voltage made signal more stable.
		173825	Echo Station initiated transmission of an RTC-1 command.
		173850	RTC-1 transmitted.
	-140 (P) -147 (E)	180928	Receiver lock was lost briefly at each station several times. Transmitter modulation off from 175840 to 180704.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 29/0839 to 29/1908

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1344 to 1856, TM-1, GM-1 / (P) 1657 to 1856, TM-1, GM-3		182104	RTC-0 initiated at the Echo Station. No response to RTC-1 has been detected.
	-141 (P)	182203	RTC-0 initiated.
		182333	SC-1 initiated.
		182402	Telemetry Channel B-2 blip observed.
		182430	SC-2 initiated.
		182450	SC-3 initiated.
		182458	Spacecraft telemetry verifies reception of SC-1.
		182940	Initiate RTC-4. Spacecraft telemetry does not indicate SC-2 or SC-3 were received.
		183323	RTC-4 initiated. No indication of spacecraft action resulting from last command.
		183725	RTC-4 initiated. No indication of spacecraft action because of previous commands.
		184230	RTC-4 initiated. No indication of spacecraft action because of previous commands.
		184817	RTC-4 initiated. No spacecraft action has occurred.
	-147 (E)	184900	No spacecraft action has occurred.
(E) 1856 to 1904, TM-1, GM-1		185636	Echo antenna in brake. Receiver at each station out of lock.
		185834	Transmitter off at the Echo Station.
		190359	After several momentary one-way RF locks tracking operations ceased at the Echo Station.
(P) 1856 to 1908, TM-1, GM-1		190836	One-way RF lock lost at the Pioneer Station. Station secured.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 29/1503 to 30/0258

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1503 to 1857 GM-3, TM-1	-137	150300	Signal level steady. Ten-second AGC time constant and 0.025-cps servo bandwidths. Telemetry Channels B-2 and B-20 in lock; Channel 8 out of lock. Receiver bandwidth was 60 cps while Goldstone was adjusting the transmitter.
		151800	Receiver bandwidth to 20 cps.
		161000	After 1550 four or five carrier dropouts occurred.
		175500	Heavy spin modulation (1 cps) and 10-db decrease in signal strength. Caused by DSIF-3 losing two-way lock.
	-135	180600	Carrier dropouts occurring every 10 minutes. Telemetry Channels B-2 and B-20 are in lock, Channel 8 is out of lock.
		180700	Back in two-way lock after several brief one-way lock periods while Goldstone was reacquiring.
	-134	182000	Signal level steady.
	-134	184500	Signal level steady. Channels B-2 and B-20 in lock, Channel 8 out of lock.
		185640	Pseudo two-way tracking terminated at end of Goldstone Echo Station tracking period.
1900 to 0258 GM-2, TM-1		190000	Begin tracking in one-way mode. Regular signal level dropouts are occurring.
		190930	Using 60-cps receiver bandwidth and 300-second AGC time constant.
	-134	192000	Signal level steady. Channels B-2 and B-20 in lock; Channel 8 out of lock.
		193000	Signal level drop outs occurring once every 14 seconds.
	-134	202000	Signal level steady.
	-134	225500	Signal level dips every 13 seconds. Receiver out of lock at 223200, 224100, 225330 and 225450.
		231500	Ten-second AGC time constant.
	-134	232000	Still experiencing signal level dropouts. Having difficulty maintaining carrier lock. The receiver tends to drift to a sideband during dropouts.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 29/1503 to 30/0258

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1900 to 0258 GM-2, TM-1		232100	AGC time constant to 300 seconds. Telemetry Channels B-2 and B-20 in lock. Channel 8 out of lock.
	-134	002000	Occasional signal level dips. Channels B-2 and B-20 occasionally out of lock.
	-135.5	014000	Occasional small dips in level.
		025800	Out of lock. End of tracking period.

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 29/2238 to 30/1016

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2238 to 0858, GM-2, TM-1		223718	Transponder signal acquired.
	-137	224730	Telemetry Channels 3, 4 and 5 in lock. Channels 1, 2 and 3 out of lock.
		225055	Receiver out of lock for 5 seconds. Servo bandwidth is 0.025 cps.
		234100	Signal level averaging -138 dbm. Variation ±1 db.
	-139	234212	Servo system shut down to check a bad clutch on the west hour angle motor.
	-168	234600	Receiver out of lock.
	-137	234900	Servo system back in autotrack. Hour angle clutch all right.
	-138	235000	All telemetry channels in marginal lock. Channel 8 is out of lock most of the time. Signal is dropping every 13 seconds, with very severe drops occurring at approximately 5-minute intervals. Phase filter makes receiver lock difficult.
		004810	Servo bandwidth 0.05 cps.
	-136	005152	All telemetry channels in lock except channel 8.
		010400	Data clock has malfunctioned.
		011827	Receiver out of lock for 7 seconds because of VCO frequency drift (1 cycle per 5 minutes).
		013200	Faulty logic caused data punch to punch out day 32 from 30/0000. Logic replaced at this time.
		014730	Tape recorder A out of order.
		015354	Replaced fuse in HT supply of tape recorder A. Tape recorder operational.
		031336	Receiver bandwidth to 20 cps.
		032518	Receiver lock reacquired after "dropouts" at 032506. Previous out-of-lock period occurred from 031936 to 032005. These losses of lock were caused by the VCO frequency drift (1 cycle/5 min.).

Table A-3. (Cont'd)

STATION: DSIF 5
VIEW PERIOD: 29/2238 to 30/1016

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2238 to 0858, GM-2, TM-1	-135.5	034731	Loss of receiver lock occurred at 035859, 040457 and from 040643 to 040714. Telemetry, except for Channel 8, is good except during times when the receiver is out of lock. Channel 8 is marginal. No trouble is being experienced locking up the discriminators.
	-135	050521	
		054100	Receiver in and out of lock between 053430 and 054058. A 2-cps spin rate makes receiver lock difficult to acquire. This spin modulation was observed at 0538.
	-134.5	070515	Signal varying ±1 db. All telemetry channels in lock. Channel 8 is marginal.
	-135	074346	
		085820	Receiver out of lock when transponder acquired the Goldstone signal.
0939 to 1017, GM-3, TM-1	-135.5	093900	Receiver in lock pseudo two-way. Because of varying frequency the signal was not reacquired until 092943. The receiver was in and out of lock between 092943 and 093620.
	-137	101540	
		101650	Receiver out of lock. Tracking concluded.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 30/0834 to 30/1912

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0834 to 0859 GM-2	-147 (E)	083400	DSIF-3 in one-way lock. The 10-kw transmitting feed has been installed in place of the tracking feed and therefore autotracking will not be done. The antenna will be positioned in either the manual or the slave mode. All telemetry channels except Channel 8 are in lock.
	-144.5 (E)	083930	Spacecraft telemetry mode is indicated as mode 3. Signal loss is occurring every 13 seconds. The tracking filter has been modified to decrease the out-of-lock periods.
		084320	Spacecraft telemetry mode indicated as mode 2. Because signal is in and out of lock the decommutator cannot be synched and the mode indication may be in error.
		085300	AGC time constant is 300 seconds.
(P) 0856 to 0859 GM-2	-145 (P)	085600	DSIF-2 in lock.
		085700	Transmitter at DSIF-3 on and searching. Transmitter power is limited to 7 kw because of high VSWR.
	-140 (P)	085725	
		085822	Receiver at DSIF-2 out of lock because of periodic signal interruption.
(E) 0859 to 1907 GM-1 (P) 0859 to 0940 GM-3		085936	DSIF-3 in two-way lock.
	-138 (P)	085941	DSIF-2 in pseudo-two-way lock.
		090300	After DSIF-3 acquired two-way lock the periodic signal interruption ceased.
		09110	DSIF-2 experienced apparent variation in transponder signal strength. Since this variation was not observed at DSIF-3 parametric amplifier problems are suspected.
		093700	DSIF-3 slaves antenna drive to coordinate converter computer commands.
		094020	DSIF-2 out of lock to check parametric amplifier.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 30/0834 to 30/1912

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0859 to 1907 GM-1		094330	DSIF-3 antenna drive servo system switched to aided track mode because of bad drive commands from the computer.
		101700	DSIF-2 begins reacquisition procedure after correcting parametric amplifier oscillation and recalibrating AGC.
(P) 1022 to 1244 GM-3	-135 (P)	102200	In pseudo-two-way lock. The antenna drive system is in the slave mode.
		103850	Telemetry mode advance command (RTC-5) transmitted at 103631 but no response obtained.
	-144.5 (E)	104800	All telemetry channels in lock except Channel 8.
		110850	Series of RTC-0s (clear commands) and RTC-5s transmitted but no response obtained.
	-140 (E)	114831	Additional RTC-5s and a series of RTC-1s were transmitted but no response was observed. Transmitter modulation turned off and transmitter VCO varied to cause a change in receiver VCO and demonstrate two-way lock.
		115320	Good two-way lock indication.
		120739	RTC-5 transmitted using emergency mode but no indication of response.
		124450	Between 123402 and 123842 a series of RTC-1's was initiated and no spacecraft response was indicated. DSIF-2 attempting to acquire the capsule. DSIF-2 using 20-cps tracking filter and 300-second AGC time constant. The antenna drive system has been in the aided track mode (manual rate selection) since 123535.
(P) 1249 to 1258 GM-4	-160 (P)	124900	DSIF-2 in lock on capsule signal.
		125700	Servo systems in slave mode at DSIF-2.
		125820	DSIF-2 out of lock to reacquire transponder signal. DSIF-3 attempted slave mode tracking but no elevation commands were received and the receiver lost lock.
		125928	DSIF-3 receiver back in lock.
	-132 (P)	125950	DSIF-2 receiver in lock on the transponder signal.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 30/0834 to 30/1912

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0859 to 1907 GM-1 / (P) 1300 to 1500 GM-3	-140 (E)	130100	Two-way lock checked by varying transmitter VCO.
		134010	From approximately 1315 to 1335 DSIF-3 transmitted RTC-5 commands every 5 minutes. No spacecraft response was observed.
		135210	DSIF-3 begins transmitting commands in midcourse maneuver command sequence.
		140010	Midcourse maneuver initiate command transmitted. No response observed.
		140514	Antenna drive system at DSIF-3 slaved to computer commands.
	-132 (P)	143100	
		143800	DSIF-3 sent two RTC-2 (antenna hinge override) commands but no signal level change was observed.
		144600	Five roll override commands were transmitted between 1439 and 1445 but no response was observed.
		144900	RTC-6 (initiate terminal maneuver) command transmitted.
	-139 (E)	145200	No response to RTC-6.
	-159 (P)	150000	DSIF-2 has stopped tracking the transponder signal and acquired the capsule signal.
(E) 0859 to 1907 GM-1 / (P) 1509 to 1736 GM-3		150425	RTC-7 (activate radar altimeter) command transmitted.
	-131 (P)	150910	DSIF-2 resumes tracking the transponder signal.
		151135	No apparent response to RTC-7. RTC-3 (antenna switchover) command transmitted.
	-139 (E)	151500	Signal level steady. No response to RTC-3.
		152400	Alternate transmission of RTC-1 and RTC-5 commands begins. Commands are punched on a continuous loop of paper tape and transmitted at 62-second intervals.
	-131 (P) -138 (E)	154900	
		164200	Still transmitting RTC-1's and RTC-5's. No response.

Table A-3. (Cont'd)

STATION: DSIF 2, 3
VIEW PERIOD: 30/0834 to 30/1912

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 0859 to 1907 GM-1 / (P) 1736 to 1912 GM-4	-159 (P) -159 (P) -142.5 (E)	173620 180510	DSIF-2 reacquires the capsule signal. Still transmitting commands. DSIF-2 still tracking the capsule signal. DSIF-2 has been using a 20-cycle tracking filter and a 300-second AGC time constant.
	-145 (E)	185800	Spacecraft nearing horizon. Signal level gradually decreasing.
		190300	Stop command transmission. Two hundred and eleven alternate RTC-1 and RTC-5 commands were transmitted.
		190730	Receiver out of lock at DSIF-3. Tracking terminated.
	-160 (P)	191030	Antenna motion stopped. Receiver still in lock on capsule signal.
		191220	Receiver out of lock at DSIF-2. Tracking terminated.
		191530	Transmitter turned off at DSIF-3.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 30/1500 to 31/0257

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1500 to 1910 GM-3	-132	150000	Transponder signal acquired. Telemetry Channels B-20 and B-2 in lock. Channel 8 out of lock.
	-131	160000	All telemetry channels in lock.
		161000	Begin search for capsule signal.
	-132	164000	Unable to acquire capsule signal. Resume tracking transponder signal.
	-134	183900	Telemetry Channels B-2 and B-20 still in lock.
	-135	190000	Signal strength slowly decreasing.
		191018	Receiver out of lock when the spacecraft transponder "lost" the Goldstone transmitter signal.
1913 to 1922 GM-2	-136	191300	Receiver in one-way lock. Receiver using 60-cps bandwidth. Receiver experiencing signal level decrease every 13 seconds.
		192200	Begin searching for capsule signal.
		193000	Resume tracking transponder signal. Capsule signal was just below receiver threshold and only about 30% in lock.
1932 to 2140 GM-2		193200	Receiver in one-way lock on the transponder signal. Receiver bandwidth is 60 cps and AGC time constant is 300 seconds.
	-138	200000	Received signal level experiencing periodic dip every 13 seconds. The receiver is not losing lock, however.
	-144.5	210000	Signal level is slowly decreasing. Telemetry Channels B-2 and B-20 in lock.
	-145	211800	Signal level steady. Channel B-2 is 80% in lock.
		214000	Attempting to acquire capsule signal.
2151 to 2325 GM-2		215000	Cease capsule tracking attempt. Only slight signal presence detected. Receiver in less than 5% of the time.
		215100	Transponder signal reacquired.
	-143	215220	Signal level beginning to increase.
	-136	215250	Signal level steady.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 30/1500 to 31/0257

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2151 to 2325 GM-2	-139	221900	Signal level steady. Channels B-2 and B-20 still in lock.
	-145	222400	
		222930	Receiver out of lock.
		223100	Receiver in lock. Channels B-2 and B-20 in lock.
	-135.5	223800	
	-131	225700	
		232500	Resume searching for capsule signal.
		240000	Stop searching for capsule signal. Very faint signals heard but no acquisition possible.
0001 to 0200 GM-2	-136.5	000100	Receiver in one-way lock on the transponder.
		002000	AGC time constant set to 10 seconds. The 30-Mc reference oscillator output was found to be zero. The 2-Mc oscillator in the 30/31 frequency converter was out of adjustment. (Zero output is hard to detect since the static phase error is zero under these circumstances). The period of time during which the receiver was operating in this manner is unknown. This misadjustment probably occurred while trying to achieve the extreme adjustment of the 31-Mc VCO required during pseudo-two-way tracking. The receiver was probably in the single phase lock loop configuration from 30/1913 when one-way tracking began.
	-131	003500	Signal level dips every 13 seconds.
		004100	The 30-Mc reference oscillator output is now correct. The system operation is normal.
	-131	011700	Occasional momentary signal drop-outs. Telemetry Channels B-2 and B-20 are in lock.
		014130	Receiver out of lock momentarily at 0140. Signal strength experienced sudden fluctuation from -120 to -140 dbm.

Table A-3. (Cont'd)

STATION: DSIF 4
VIEW PERIOD: 30/1500 to 31/0257

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		020000	Attempt acquisition of capsule signal.
		021500	Stop capsule tracking attempt and begin reacquisition of transponder signal. The receiver was 50% in lock on the capsule signal for about 3 minutes.
0218 to 0257 GM-2	-132	021800	Receiver in one-way lock on the transponder signal.
		022200	Telemetry Channels B-2 and B-20 in lock. Signal level dips still occurring.
		025700	Antenna tracked into prelimits. Tracking concluded.

Table A-3. (Cont'd)

STATION: DSIF-5
VIEW PERIOD: 30/2232 to 31/1016

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2232 to 1016 GM-2		223148	Initial acquisition of the transponder signal.
	-138	223800	After two losses of lock autotrack was achieved. The telemetry to teletype converter has been inoperative since 181500 and repairs are in progress.
	-137	224300	All telemetry channels, except Channel 8, are in lock. The received signal is experiencing phase transients every 13 seconds.
	-136	230000	Telemetry teletype converter is operational but time readout is inaccurate.
	-136	234000	Receiver in and out of lock for short periods.
	-136	010000	All telemetry channels in lock except Channel 8.
	-136.5	020000	Data system readout corrected to read day 31 instead of day 33.
		022730	Signal faded to below threshold. Receiver out of lock.
	-138	023002	Transponder signal reacquired.
	-136.5	032200	All telemetry channels in lock except Channel 8.
		044448	Receiver momentarily out of lock three times.
	-136	045630	All telemetry channels in lock except Channel 8.
	-136.5	062000	All telemetry channels in lock except Channel 8.
		081400	Receiver momentarily out of lock.
		083400	
	-137	100000	All telemetry channels in lock except Channel 8.
		101300	Antenna into prelimits.
		101619	Receiver out of lock. Tracking concluded.

Table A-3. (Cont'd)

STATION: DSIF-2, 3
VIEW PERIOD: 31/1033 to 31/1913

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		103300	DSIF-3 experiencing trouble with transmitter introducing noise and spikes into the receiver. An attempt was made to lock up on the transponder but the noise and spikes were still present. DSIF-3 ceased tracking attempts and continued work on transmitter repairs.
		103400	DSIF-2 slaved to the coordinate computer commands.
(P) 1035 to 1430, GM-2	-129	103540	DSIF-2 in one-way lock. A linear polarized Cassegrain feed has been substituted for the circular polarized feed used in the four previous tracking periods. The parametric amplifier has been moved from the sum channel to the declination error channel and a compensating attenuator pad has been added to the sum channel. The data system format is being reprogrammed to the standard Ranger 3 format. (Previously DSIF-2 had been recording and transmitting the transmitter VCO reference frequency from DSIF-3).
	-125(P)	105400	
		111000	Data being sent in standard data format.
		112900	Intermittent loss of RF lock due to variation in transponder signal.
		114000	Received signal varying 15 db about -125 dbm.
		114400	Switch to 60-cycle tracking filter.
	-135	115500	Signal level variation of 10 db. The receiver is 90% in lock. Receiver lock is lost every 13 seconds.
	-130	124500	Signal level variation 10 db. All telemetry channels in lock except Channel 8. Still having difficulty staying in lock.
	-130	134500	Signal level variation 10 db. Still having difficulty keeping the receiver in lock.
		143000	Begin attempts to acquire the capsule signal.
		144200	Capsule signal acquired but RF lock cannot be obtained. System threshold with new configuration is approximately -163 dbm.

Table A-3. (Cont'd)

STATION: DSIF-2, 3
VIEW PERIOD: 31/1033 to 31/1913

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(A)	-155	145200	One-way lock.
		152200	Stop tracking capsule signal and begin transponder acquisition attempts.
(P) 1530 to 1560 GM-2	-130	153010	One-way lock on the transponder signal.
	-145	154500	Signal level variation 5 db.
		155000	DSIF-3 turns on transmitter using 5 kw. Attempting acquisition with the receiver.
(B)		155700	Receiver at DSIF-3 in one-way lock.
		155938	DSIF-2 out of lock.
(E) 1600 to 1853 GM-1	-144	160000	DSIF-3 in two-way lock.
	-154	161340	DSIF-2 cannot lock up reference loop.
(P) 1621 to 1643 GM-2		162100	DSIF-2 in one-way lock.
	-140	162200	Signal strength varying 14 db.
		164040	DSIF-3 receiver back in lock after several brief losses of lock.
		164110	Antenna switchover command transmitted.
(P) 1643 to 1853 GM-3	-138(P)	164300	Receiver at DSIF-2 in pseudo-two-way lock.
		165800	DSIF-2 personnel had trouble keeping the receiver in lock between 1653 and 1658 because the transmitter VCO at DSIF-3 was being varied to check the two-way lock condition.
		182040	Between 164110 and 182040 20 antenna switchover commands were transmitted. The modulation frequency was varied for some of these commands but no response was obtained from the spacecraft. Signal levels varied considerably during this time. Signal levels at DSIF-3 generally varied around -145 dbm with excursions as low as -160 dbm and as high as -126 dbm. At DSIF-2 signal levels generally varied approximately 10 db about -145 dbm with excursions to as high as -111 dbm.

A. (P) 1452 to 1522, GM-4
B. (E) 1557 to 1600, GM-2

Table A-3. (Cont'd)

STATION: DSIF-2, 3
VIEW PERIOD: 31/1033 to 31/1913

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(E) 1600 to 1853 GM-1 (P) 1643 to 1853 GM-3	-150(E)	182500	Spacecraft commutator stopped for about 30 seconds but resumed operation. Operation appears erratic however.
	-147(E)	185100	Spacecraft commutator has stopped.
		185324	DSIF-2 and 3 both out of lock.
		185419	Antenna switchover command transmitted. No response.
		190407	Antenna switchover command transmitted. No response.
		190600	Servo in brake at DSIF-3. Antenna motion stopped. DSIF-3 ceases participation in the RA-3 mission.
		190900	DSIF-2 acquired capsule signal but could not get a receiver lock. Signal strength estimated as -160 dbm.
		191325	Spacecraft below DSIF-2 horizon. Capsule signal disappeared. Tracking concluded.

Table A-3. (Cont'd)

STATION: DSIF-4
VIEW PERIOD: 31/1457 to 31/2352

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1457 to 1600 GM-2		145700	Acquired transponder in one-way lock. Telemetry Channels B-2 and B-20 are in lock. Channel 8 is out of lock. As usual signal level drops are occurring every 13 seconds but are not sufficient to cause loss of lock.
	-136	145800	Signal level decreasing.
	-143	150000	Signal level decreasing.
		152000	Receiver occasionally loses lock and also has regular loss of lock because of periodic signal drop out. Telemetry channels B-2 and B-20 are in lock at the higher signal levels.
1600 to 1853 GM-3		160000	Spacecraft transponder acquires Goldstone transmitter signal, tracking now being done in the pseudo-two-way mode. After pseudo-two-way doppler condition was established the periodic signal dropouts stopped.
		170000	Receiver still occasionally loses lock. Signal level still varying. Signal level generally between -135 and -150 dbm with occasional excursions to as high as -121 dbm and as low as -160 dbm.
		182000	Signal level still varying.
		185324	Receiver out of lock. Begin searching for transponder signal.
	-150	194630	Signal acquired but frequency unsteady.
		195400	Receiver out of lock. Large signal strength dropout occurred causing receiver to go out of lock. Begin searching for transponder signals.
		202800	Receiver appears to be in lock for 1-2 seconds every 14 seconds.
		210000	Transponder signal very weak. Receiver was in lock from 2031 to 2037 and signal strength varied from -140 dbm to below threshold.
		211000	Receiver out of lock after lock at 2108 with signal of -159 dbm.
		214300	Receiver out of lock after lock at 2138 with signal strength of -146.5 dbm.

Table A-3. (Cont'd)

STATION: DSIF-4
VIEW PERIOD: 31/1457 to 31/2352

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		221100	Receiver out of lock after signal was acquired at 2206. Data samples were taken once per 10 seconds.
		223825	Intermittent receiver lock from 223540. Ten-second data sample rate used during this time.
		230500	Search for transponder signal terminated. Receiver was in intermittent lock from 225900 to 230215. Ten-second data sample rate used during this time.
		233600	Begin searching for capsule signal.
		235200	Capsule signal search discontinued. No signals heard. Tracking operation concluded for the day.

Table A-3. (Cont'd)

STATION: DSIF-5
VIEW PERIOD: 31/2234 to 01/0935

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		215500	Antenna positioned at acquisition point.
		221400	Receiver searching for signal.
		223400	No signal detected.
2234 to 0834 GM-2 (periodically)		223430	Faint signal acquired.
		223454	Receiver in lock.
		223738	Receiver out of lock, resume search for transponder signal.
		230000	Receiver in lock.
		230212	Receiver out of lock after several intermittent locks. Signal strength varying from -150 dbm to threshold.
		231100	Antenna pointed at collimation tower to check servo-system and receiver.
		232600	Systems checks indicate everything normal. Begin searching for spacecraft using prediction data.
	-140	234522	Signal reacquired. Servo in autotrack. Data being sampled every 10 seconds. Signal level varying.
		234800	Signal lost. Between acquisition periods sampling every 120 seconds; during acquisition every 10 seconds.
	-145	000714	Receiver in lock. Servo in autotrack. Data being sampled.
		000838	Receiver out of lock.
	-142	003027	Receiver in lock after series of intermittent locks.
		003204	In and out of lock.
	-141.5	004949	In lock. Servo in autotrack. Sampling data.
		005200	Lost signal.
	-140	013020	In lock after intermittent locks.
		013420	Out of lock.
		014940	In lock. Servo in autotrack.
		015014	Out of lock.
	-142	020824	Receiver in lock. Servo in autotrack.
		020942	Receiver out of lock.
		022700	Receiver in lock.
		022800	Receiver out of lock.

Table A-3. (Cont'd)

STATION: DSIF-5
VIEW PERIOD: 31/2234 to 01/0935

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2234 to 0834 GM-2 (periodically)	-141.5	024518	Receiver in lock. Period between acquisitions is approximately 18 minutes.
		024638	Out of lock.
		030306	Signal reacquired.
		030449	Receiver out of lock.
	-145	031902	Receiver in lock.
		032050	Receiver out of lock.
		033805	In lock. Servo in autotrack.
	-142	034010	Receiver out of lock.
		035458	In lock.
		035633	Out of lock.
		041153	In lock.
		043001	Out of lock.
		043500	Telemetry discriminators cannot be locked in brief acquisition periods.
	-139	044350	In lock.
		044609	Out of lock.
	-144.5	050054	Acquired signal frequency.
		050329	Lost signal.
	-141.5	051745	Acquired signal.
		051850	Lost signal.
	-146	053221	Acquired signal.
		053315	Lost signal.
	-139.5	054800	Receiver in lock.
		055045	Out of lock.
	-136.5	060450	In lock.
		060636	Out of lock.
		061958	In lock.
	-141	062135	Lost signal.
		063100	Changed HA bandwidth to . 05 cps.
		063457	In lock.
	-149	063737	Lost signal.
	-143.5	064950	Acquired signal. Channel 2 intermittent.
		065100	Lost signal.

Table A-3. (Cont'd)

STATION: DSIF-5
VIEW PERIOD: 31/2234 to 01/0935

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2234 to 0834 GM-2 (periodically)	-141.1	070520	Receiver in lock.
		070652	Out of lock.
	-143	072040	In lock.
		072100	Out of lock.
		073458	Receiver in lock.
		073651	Out of lock.
		074916	Acquired signal.
		075100	Out of lock.
		080100	Missed acquisition. Tried to acquire beacon.
		081900	In lock.
		082033	Out of lock.
	-140	083400	In lock.
		083438	Out of lock.
0837 to 0935 GM-4	-150	083700	Beacon acquired.
		083843	Out of lock.
	-156	085023	Beacon frequency.
	-161	085100	
		085400	Out of lock.
		085450	Receiver searching on beacon frequency.
	-155	090118	Receiver in lock.
		090712	Receiver out of lock.
	-153	091500	Acquired beacon frequency. Servo in autotrack. All data channels marginal or out of lock.
		091900	Antenna stopped. Antenna-servicer obstructing antenna - moved.
		092500	Acquired signal at threshold.
		093500	Lost signal. Postflight calibration commencing.

Table A-3. (Cont'd)

STATION: DSIF-4
VIEW PERIOD: 01/1456 to 01/2300

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		144200	Servo to acquisition point.
		145500	Start data sampling and recording.
	-149	145550	In lock.
	-143	145630	Out of lock. Servo briefly in auto.
	-147	150800	In lock.
	-155	150910	Out of lock.
	-145	151909	In lock. Servo in auto.
		152010	Out of lock. Servo to aided track.
	-150	153030	In lock. Signal strength steady immediately after acquisition. Then falls off rapidly.
	-139	153125	
		153230	Out of lock.
		153300	Searching for beacon.
		160300	Searching for transponder. Search for beacon signal unsuccessful.
	-147	161700	In lock.
		161840	Out of lock.
	-145	162851	In lock.
		163020	Out of lock. Search for transponder unsuccessful.
		1633	Searching for beacon. Unsuccessful.
		1707	Searching for transponder.
	-140	171400	In lock.
		171520	Out of lock.
	-144	172510	In lock.
		172650	Out of lock.
		173600	Transponder search continues. No success.
		180300	Searching for transponder.
	-142	180850	In lock.
		181015	Out of lock.
	-140	181930	In lock.
		182125	Out of lock.
	-150	183140	In lock.
		183250	Out of lock.
		183400	Begin search for beacon signal.

Table A-3. (Cont'd)

STATION: DSIF-4
VIEW PERIOD: 01/1456 to 01/2300

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		183600	No beacon signal.
		190500	Terminate beacon search. No success.
	-155	191350	In lock on transponder signal.
		191503	Out of lock.
	-150	192612	In lock.
		192645	Out of lock.
		193000	Discriminator Channels changed to 2, 3, and 4 to observe telemetry commutator. In lock period too short to give indication.
	-145	193648	In lock.
		193655	Out of lock.
		194000	Start beacon search.
	-159	194935	In lock.
		194955	Out of lock.
	-161	201015	In lock.
		201118	Out of lock.
		201400	Terminate beacon search. Unsuccessful.
		201500	Begin transponder search.
	-157	201924	In lock.
		201945	Out of lock.
		204500	Terminate transponder search. Unsuccessful.
		205700	Begin beacon search.
		212000	Terminate beacon search. Unsuccessful.
		212100	Begin transponder search.
	-157	214040	In lock.
		214100	Out of lock.
	-152	215056	In lock.
		215130	Out of lock. Transponder search unsuccessful.
		215200	Begin beacon search.
		221100	Terminate beacon search.
		221101	Begin transponder search.
	-150	222130	In lock.
		222220	Out of lock.
	-161	223105	Momentary lock.

Table A-3. (Cont'd)

STATION: DSIF-4
VIEW PERIOD: 01/1456 to 01/2300

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
	-156	223210	Momentary lock.
	-140	224125	In lock.
		224230	Out of lock.
		224300	Start beacon search.
		230000	End of track. Data sampling and recording stopped.
			Time in lock - 4%.

Table A-3. (Cont'd)

STATION: DSIF-5
VIEW PERIOD: 01/2230 to 02/1000

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		2230	Searching for S/C transponder.
		2300	Searching for beacon.
		2330	Searching for transponder.
		0000	Searching for beacon.
		0030	Searching for transponder.
		010840	Receiver momentarily in lock. (Too short for signal level).
		0116	Searching for beacon.
		0130	Searching for transponder.
		0200	Searching for beacon.
		0230	Searching for transponder.
	-145	0234	Receiver momentarily in lock.
		0300	Searching for beacon.
		0330	Searching for transponder.
		0400	Searching for beacon.
			Half hour searches were continued until 1000 when antenna ran into prelimits. No tracking or telemetry data recorded.

Table A-3. (Cont'd)

STATION: DSIF-4
VIEW PERIOD: 02/1521 to 02/1722

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		1438	Antenna to acquisition point.
		1448	Data sampling and recording started.
	-157	1521	Receiver in lock momentarily.
		1559	Receiver switched to beacon frequency. Transponder search unsuccessful.
		1659	Beacon search ended. No acquisition.
		1700	Transponder search.
		1722	Tracking terminated. No acquisition.

IV. *RANGER 4* OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-22–A-28) for the *Ranger 4* space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary in the form of edited station logs. Translations of the code names used in Table A-4 to identify the space communication stations of the DSIF are contained in Section I of this appendix. Definitions of the ground station operational mode codes are given in Section III of this appendix.

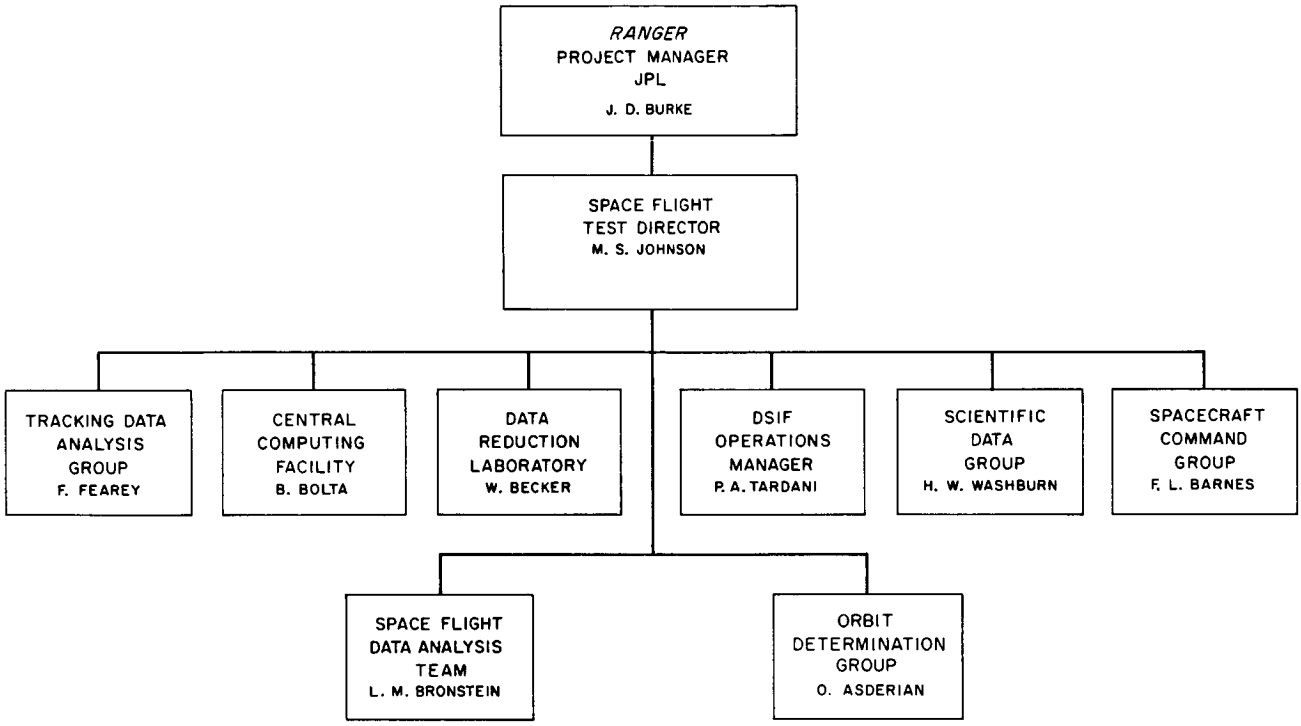
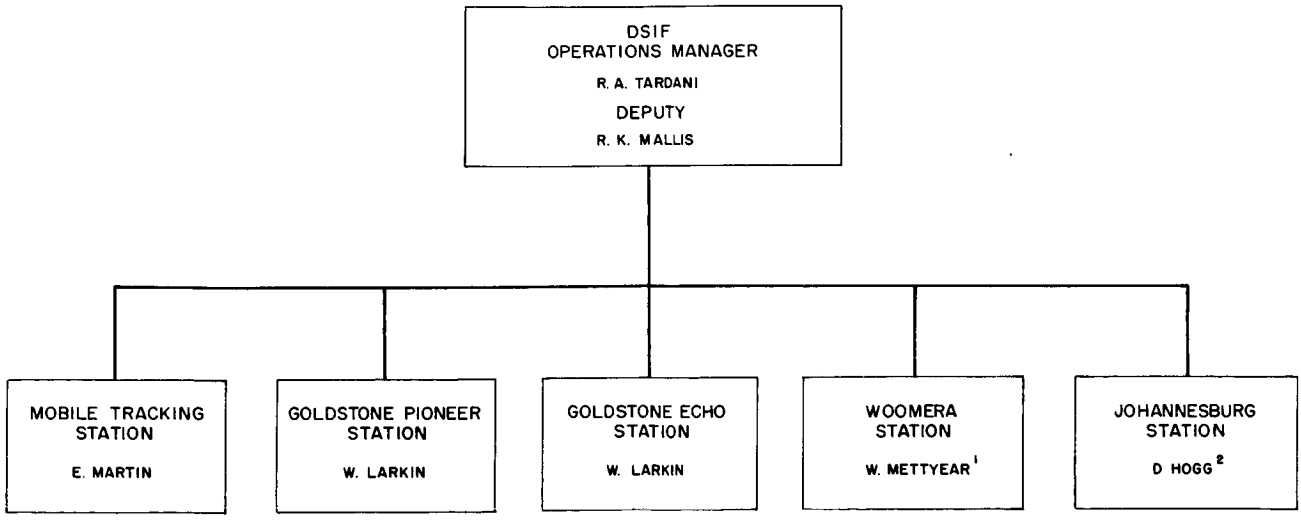


Fig. A-22. Space flight operations organization for *Ranger 4*



[1] WEAPONS RESEARCH ESTABLISHMENT OF THE DEPARTMENT OF SUPPLY, COMMONWEALTH OF AUSTRALIA
[2] NATIONAL INSTITUTE OF TELECOMMUNICATIONS RESEARCH, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF THE REPUBLIC OF SOUTH AFRICA

Fig. A-23. DSIF operations organization for *Ranger 4*

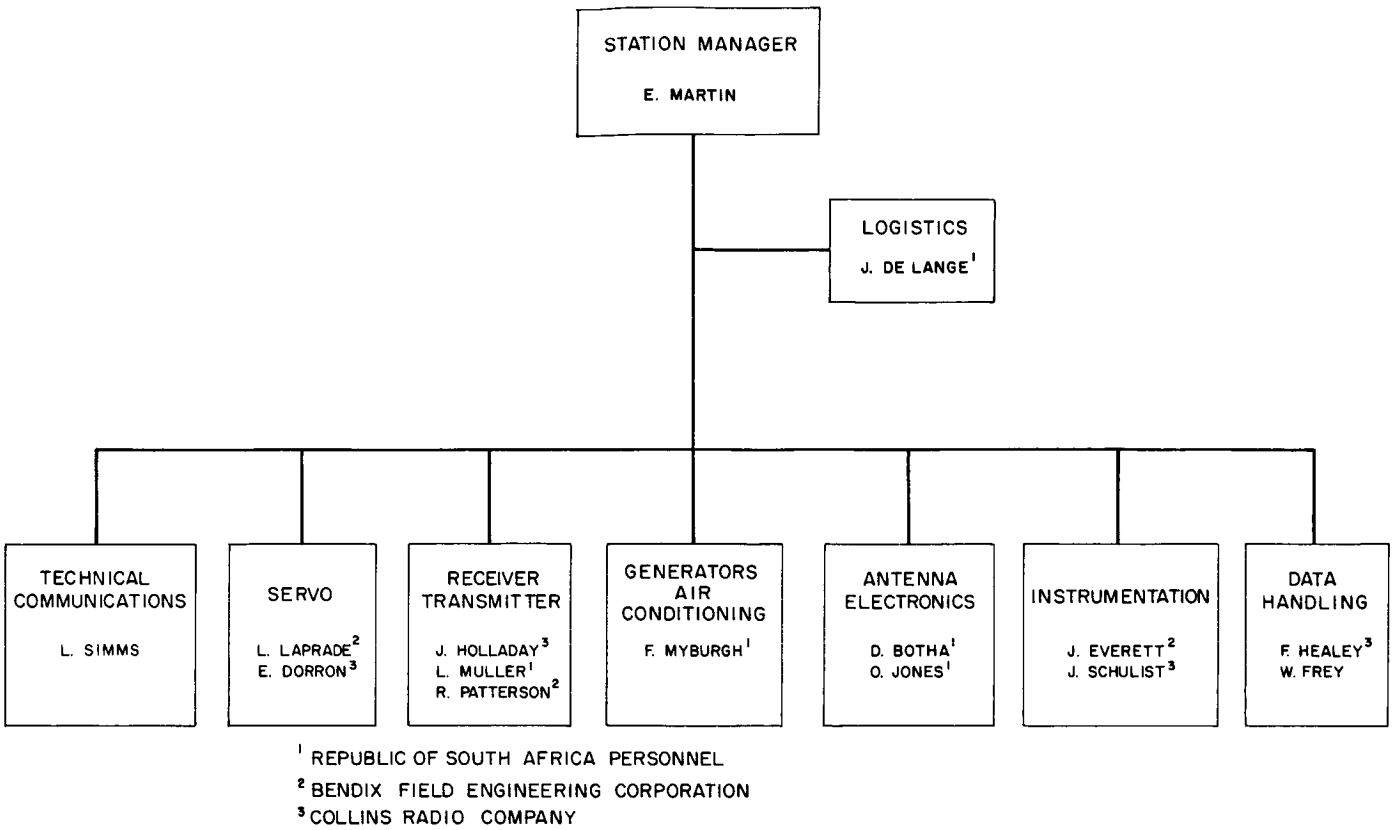


Fig. A-24. Mobile Tracking Station organization for *Ranger 4*

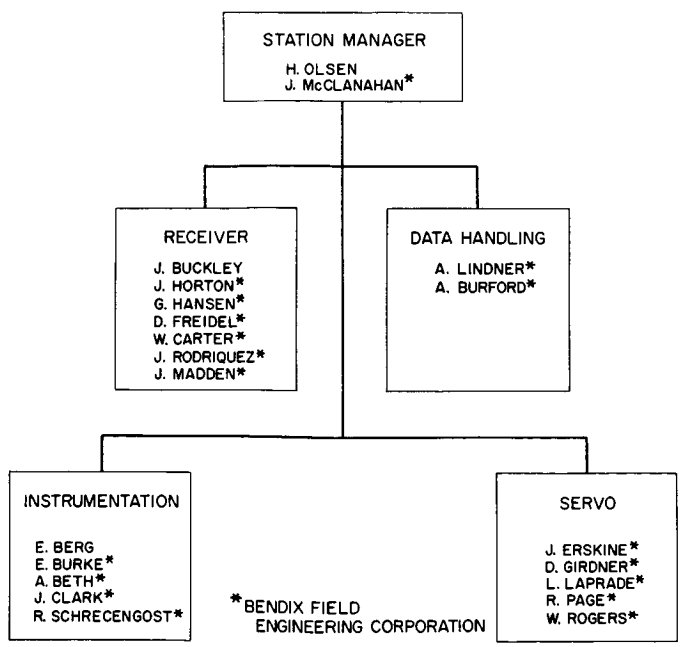


Fig. A-25. Goldstone Pioneer Station organization for *Ranger 4*

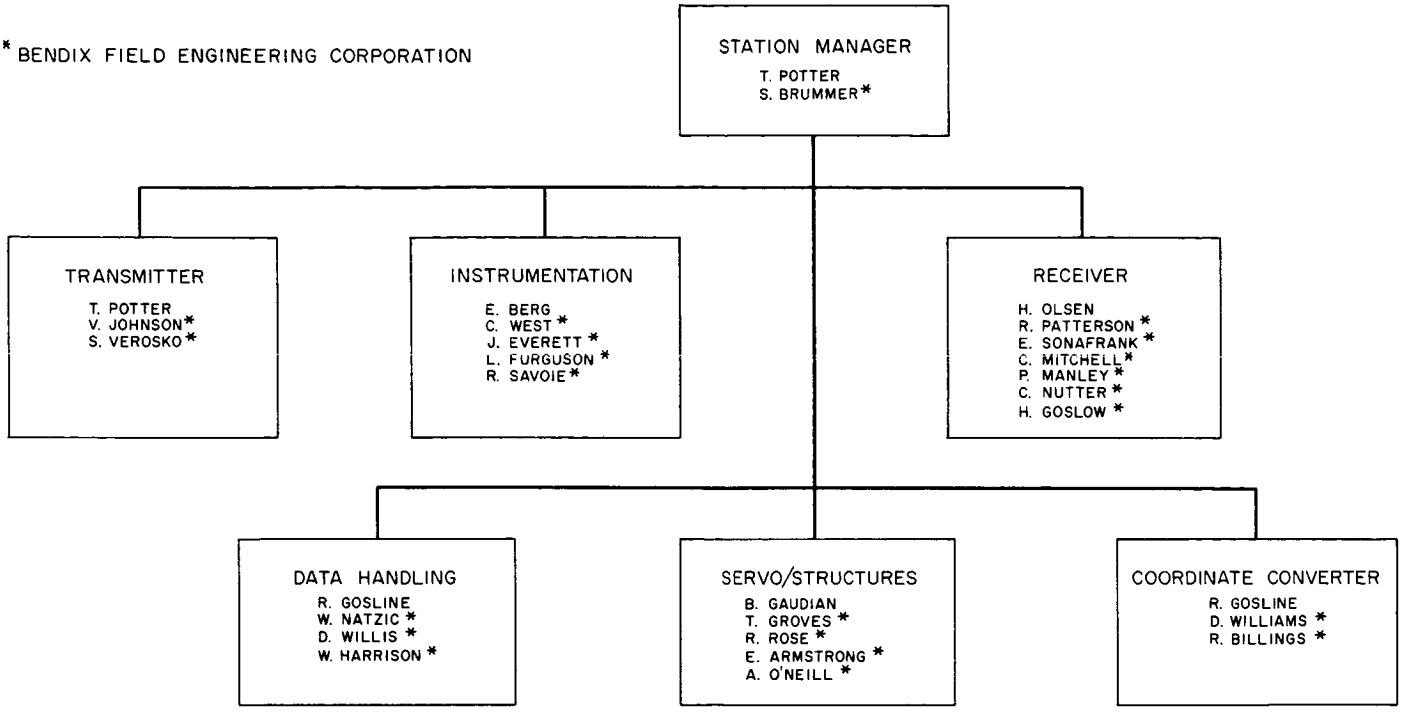


Fig. A-26. Goldstone Echo Station organization for *Ranger 4*

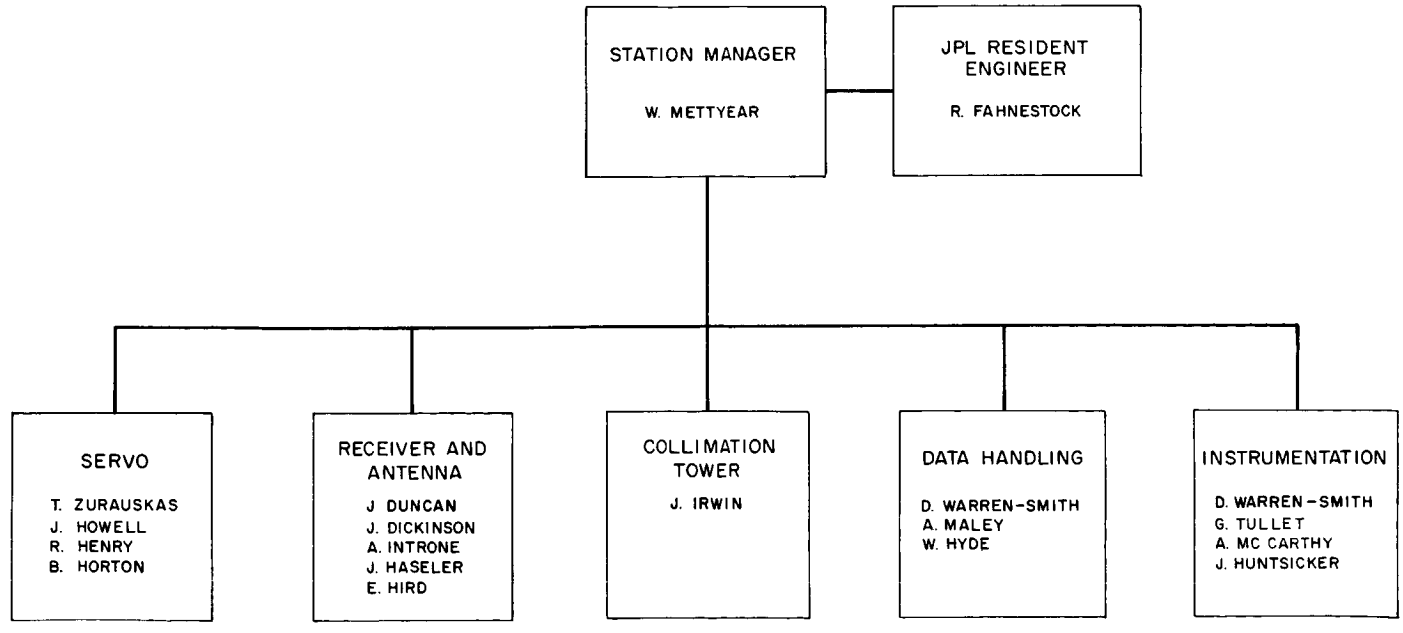


Fig. A-27. Woomera Station organization for *Ranger 4*

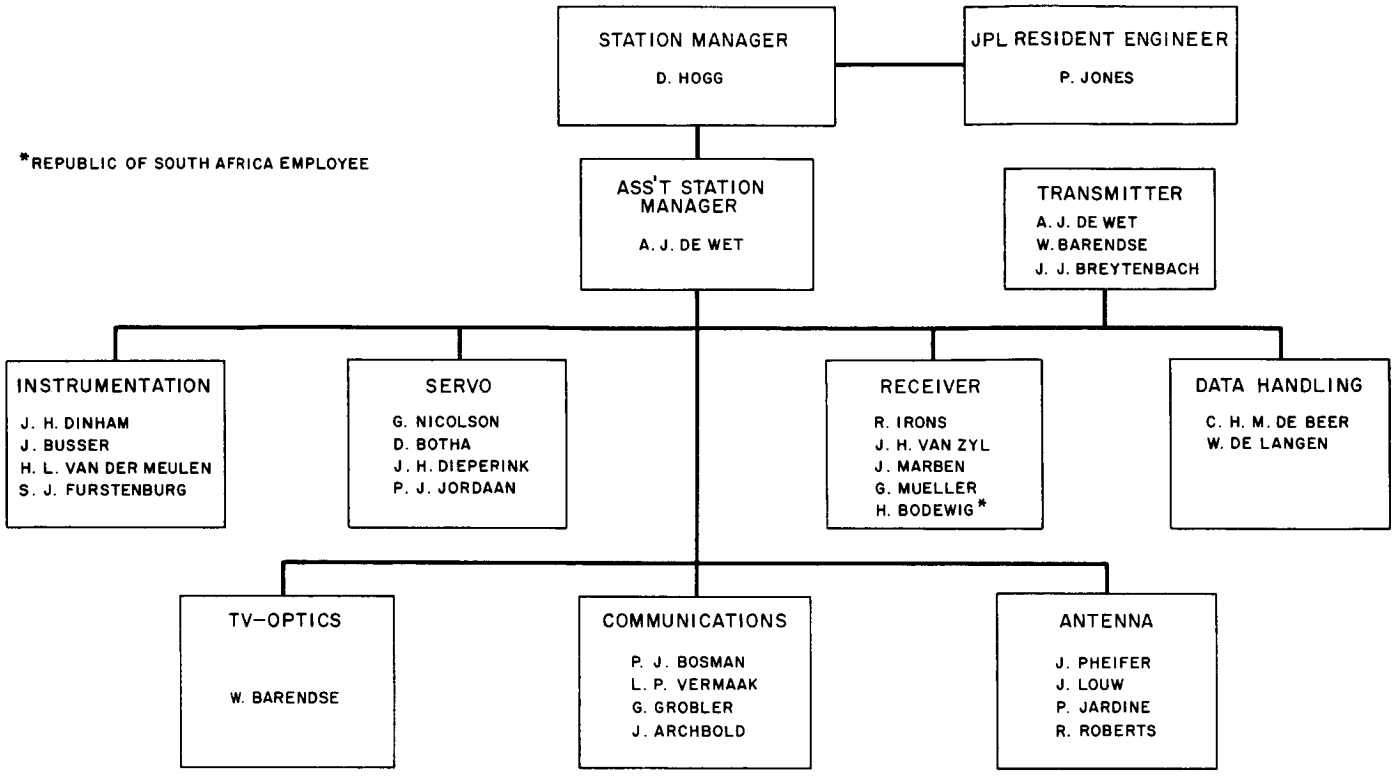


Fig. A-28. Johannesburg Station organization for *Ranger 4*

Table A-4. *Ranger 4* tracking operations summary

STATION: DSIF-1

VIEW PERIOD: Apr. 23/2113 to 24/0835

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		211300	Signal on horizon. Transmitter is on with 25 watts.
		211319	One-way acquisition[1]. Unable to lock channel 1.
			Channels 2, 5 and 6 very noisy. No commutation on
			any of the engineering measurement channels.
		211335	Out of lock.[1]
		211339	One-way lock.[1] [2]
		211427	Out of lock.[1]
		211430	One-way lock.[1]
		211441	Out of lock.[1]
		211446	One-way lock.[1]
		211530	Auto track.[1]
		211600	Out of lock. Aided track.[1]
		211634	One-way lock.[1]
		211640	Auto track.[1]
		211816	Out of lock. Aided track.[1]
		211840	One-way lock.[1]
		211858	Auto track.
	-118	212018	Two-way lock reported to JPL.
		212133	To aided track.[1]
		212135	Out of lock.[1]
		212137	One-way lock.[1]
		212154	Out of lock.[1]
		212201	One-way lock.[1]

1) Read from station analog records.
2) Post-mission study of the available spacecraft telemetry indicates DSIF-1 was successfully interrogating the transponder after 211339.

Table A-4. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Apr. 23/2113 to 24/0835

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		212210	Out of lock. 1)
		212220	One-way lock. 1)
		212237	To auto track. 1)
		212455	To aided track. 1)
		212458	Out of lock. 1)
		212504	One-way lock. 1)
2126 to 2305, GM-1		212552	Two-way acquisition. 1)
		212838	Out of lock. 1)
		212848	Two-way lock. 1)
		212907	Auto track. 1)
	-130	215755	Switched to wide band.
		220400	Out of lock.
	-127	220445	In lock. Bandwidth 20 cps.
		221318	Out of lock.
	-128	221354	In lock.
		230500	Transmitter off.
(A)	-134	230722	Bandwidth to 60 cps. Two-way lock.
		233617	DSIF-5 transmitter off. Reacquired in one-way lock.
(B)	-135	234000	Transmitter on at 2338. Two-way acquisition.
		000600	Out of lock. Transmitter off.
0007 to 0723 GM-3		000734	In lock - pseudo two-way. DSIF-5 transmitter on.
	-132.5	000928	Bandwidths to 20 cps.
		002030	Channels 1, 2, 5, and 6 out of lock. The remaining channels in lock: 3, 4 B-2, B-19, B-20

1) Read from station analog records.
(A) GM-3 2307 to 2336
(B) GM-1 2340 to 0006

Table A-4. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Apr. 23/2113 to 24/0835

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0007 to 0723, GM-3		012800	Changed to 1-minute data sampling rate.
		015750	All channels out of lock.
		015812	Receiver back in lock.
		020000	All channels in lock except 1, 2, 5 and 6.
		020209	B2-2 blip indication.
		020221	B2-2 blip indication. Blips could have been caused
			by discriminator dropping lock.
		020402	Receiver out of lock.
		020425	Receiver in lock.
		020430	All channels back in lock except 1, 2, and 6.
			Difficulty in holding 4 in lock.
	-140	020535	
		021500	SC-1 sent from DSIF-5
		022200	RTC-5 sent from DSIF-5
		022700	RTC-5 sent from DSIF-5
		023115	Out of lock.
		023123	Receiver in lock.
		023300	RTC-5 sent from DSIF-5.
		023310	Receiver out of lock.
	-138	024120	In lock after intermittent locks of 2 or 3 minutes
			duration.
		031435	Out of lock.
	-140	031918	In lock after intermittent locks.

Table A-4. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Apr. 23/2113 to 24/0835

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0007 to 0723, GM-3 ↓		040200	Turned off digital printer.
		042100	Broken pen on Sanborn Channel 7.
		043300	Pen replaced and recording.
		044710	Out of lock.
		044800	DSIF-5 transmitter sweeping in frequency.
	-142	050303	In lock.
		050600	Broken pen on Sanborn Channel 7.
		051100	Pen replaced and recording.
		051200	Antenna switchover command initiated from DSIF-5.
		064703	Out of lock.
	-142	064808	In lock.
		071920	Out of lock.
	-146	071923	In lock.
		072300	Loss of signal. Begin searching for signal.
		083520	Search unsuccessful. Station secured.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 23/2114 to 24/0843

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		211422	Transponder signal first heard.
2114 to 2305, GM-3 [2]		211437	Receiver in lock. [1]
		211441	Receiver out of lock. [1]
		211445	Receiver in lock. [1]
		211449	Servo to auto. [1]
		211517	Receiver out of lock. [1]
		211522	Servo to aided. [1]
		211533	Receiver in lock
		211617	Receiver momentarily out of lock. [1]
		211628	Switched to main antenna.
	-87	211706	Good data.
		211817	Receiver out of lock. [1]
		211822	Servo to aided. [1]
		211827	Receiver in lock. [1]
		211832	Servo in auto. [1]
		211906	Good data.
		211920	Receiver out of lock. [1]
	-92	211922	Receiver in lock. Servo aided. [1]
		211925	Servo to auto. [1]
		212011	Discriminators back in lock, but no sync pulses
			on channel B-19.
		212458	Receiver out of lock. [1]
		212500	Servo to aided. [1]

1) Read from station analog records.
2) DSIF-1 was interrogating the transponder intermittently until 212848 when a solid lock was obtained.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 23/2114 to 24/0843

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2114 to 2305, GM-3		212605	Receiver in lock. 1)
		212621	Servo auto. 1)
		212628	Instrumentation power failure 1) because of fault
			in precision frequency power supply of tape recorder
			B (main breaker tripped).
		212646	Good data.
		212707	Receiver out of lock to check doppler loops.
		212750	Instrumentation power restored. 1)
		212752	Receiver back in lock. Servo auto.
		212806	Good data.
		212839	Receiver out of lock. 1)
		212854	Receiver in lock. Servo auto. 1)
		213223	Receiver out of lock 1) to sync. doppler loops.
			Servo to aided. 1)
		213405	Receiver in lock. 1)
		213425	Servo to auto. 1)
		213506	Good data.
		213535	Servo HA in low speed. Bandwidth 0.1 (both axis)
	-95	213629	
		213720	All telemetry channels except 1 in lock.
	-132	2200	Signal strength dropped suddenly.
		2225	Sample rates changed to 1-minute sample, 50-second
			doppler count. (This had been 10-second sample and 5-second count from acquisition)

1) Read from station analog records.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 23/2114 to 24/0843

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2114 to 2305 GM-3	-115	2243	Signal strength dropped.
		230543	Receiver out of lock (MTS transmitter off).
		230559	Reacquired.
		230700	Transmitter on, locked transponder two-way.
2308 to 2336 GM-1		230755	Receiver locked. Servo auto.
		230820	Reacquired to lock doppler loops.
		231143	Receiver out of lock. Reason unknown.
		231418	Receiver in lock.
		233600	Transmitter off. Receiver out of lock.
GM-2		233704	Receiver in lock, then out again.
2340 to 0006 GM-3		233954	Receiver in pseudo two-way lock. (MTS in two-way lock.)
	-110	000310	Signal strength. (Note signal strength had been changing
			in an approx. 4-minute cycle with variation about
			10 dbm).
		000600	Receiver out of lock (MTS Transmitter off).
		000700	Transmitter on.
0008 to 0240, GM-1	-110	000754	Receiver in lock. Signal strength fluctuations not as
			great as before.
		015220	Sent commands: RTCO Initiate 015220Z Verify 015302Z
			RTCO Initiate 015323Z Verify 015402Z
			Command 25-3252-1 (SC1) 015700Z 015742Z
			Results of these commands were negative.
		015752	Receiver out of lock and back again. (Do not believe this was a result of commands.)

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 23/2114 to 24/0843

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS		
0008 to 0240, GM-1		020205	Receiver in and out of lock.		
		020236	Receiver in and out of lock.		
		021150	Commands RTC-0	Initiate 201150Z	Verify 021228Z
			sent RTC-0	021249Z	021327Z
		021500	SC-1	021500Z	021540Z
		022200	RTC-5	022200Z	022240Z
		022700	RTC-5	022700Z	022740Z
		023119	Receiver out of lock (cause unknown).		
		023358	Receiver finally relocked after intermittent		
			ins and outs.		
		024000	Transmitter tripped out.		
GM-2		024055	Receiver in one-way lock.		
		024132	Transmitter on and receiver locked.		
0242 to 0722, GM-1		025300	Commands sent as follows:		
			RTC-5	Initiate 023300	Verify 023340
			RTC-5	024300	024340
			RTC-5	024800	024840
		031500	Commands RTC-0	Initiate 031500	Verify 031541
			RTC-3	031601	031640
			Negative results from these commands.		
		031920	Receiver out of lock as transmitter changed frequency.		
		044900	Instructed to sweep transmitter frequency until		
			receiver went out of lock and then to set VCO frequency at center of high and low drop-out points.		

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 23/2114 to 24/0843

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0242 to 0722, GM-1		050230	Receiver in lock again with transmitter
			VCO set at 29.668260.3 Mc
		050500	Following commands sent:
			RTC-0 Initiate 050510 Verify 050550
			RTC-0 050611 050650
			RTC-3 0051200 051240
		052350	Receiver out of lock to measure relative
			levels of 1st and 2nd upper and lower
			sidebands relative to carrier as requested
			by DSIF Net Control.
		054200	Receiver back in lock after tests.
		055000	Following commands sent:
			RTC-0 Initiate 055000 Verify 055040
			RTC-2 055200 055240
		064705	Receiver out of lock (reason unknown).
		064723	Receiver relocked, servo to auto.
		065200	HA and Dec bandwidths changed to 0.25 cycles.
		070555	Oscillation noticed on telemetry channel 8.
		071000	Channel 8 out of lock as signal strength dropped
			to -129 dbm.
		071300	Channel 8 back in lock.
	-134	072000	Signal strength starts dropping rapidly and all
			discriminators out of lock.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 23/2114 to 24/0843

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0242-0722 GM-1 ↓		072150	Receiver out of lock.
		072541	Transmitter off.
		072545	Instructed search for capsule.
		081136	Receiver momentarily in lock on capsule.
↑ 0814 to 0843, GM-4 ↓		081430	Receiver in lock on capsule servo auto.
	-146	081519	
		081609	Receiver out of lock.
	-146	081623	Receiver back in lock.
		081652	Receiver out of lock and back at 081708.
		082100	Receiver out of lock.
	-146	082141	Back in lock, servo auto.
		082740	Receiver out of lock.
	-152	082840	Back in lock.
	-144	083055	
		083227	Channel 2 in lock for short time.
		084010	Receiver out of lock.
		084102	Back in lock, servo auto.
		084320	Receiver out of lock - antenna in western prelimits.
			End of first day's tracking.

Table A-4. (Cont'd)

STATION: DSIF-4 (first pass)

VIEW PERIOD: Apr 23/2222 to 24/0006

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2222 to 2240 GM-3		222200	Acquired below polar mask in 60-cps bandwidth.
	-128	222300	Receiver bandwidth to 20
		223129	Good autotrack.
	-113	223600	Signal level slowly varying over 4-minute period.
			7 db peak to peak
		224000	Switch to capsule frequency.
2243 to 2300 GM-4	-142	224300	In lock on capsule signal. In autotrack.
	-136	224600	
	-136	225420	Channel 2 in solid lock when above threshold.
	-140	230000	Ceased capsule track.
2300 to 2335, GM-3	-114	230010	In lock and autotrack.
		230548	DSIF-1 transmitter off. In one-way lock.
		230720	DSIF-5 transmitter on. In pseudo two-way lock.
	-118	231400	Signal level varying over a 4-minute period. 8 db
			peak to peak. Channels B2, B20 and 8 all in solid
			lock.
	-121	232500	
	-116	233500	
GM-2		233604	DSIF-5 transmitter off.
	-120	233700	
2338 to 0006 GM-3		233836	DSIF-1 transmitter on. Pseudo two-way lock.
	-116	234300	
	-123	234600	
	-122	235000	Stop autotrack
		000600	Out of lock. End of first pass.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr 24/0832 to 1703

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		082800	Data recorders started.
		082902	Servo in slave to coordinate converter.
0832 to 1703, GM-4	-154	083240	Receiver in lock. Intermittent signal. As signal
			strength improved, attempt was made to switch from
			60- to 20-cycle tracking filter, but proved unsuccess-
			ful. Returned to 60 cycles.
	-152	084304	
	-148	084443	
	-144	084548	
	-147	084730	Signal decreasing.
	-147	085207	
		085741	Signal strength varying (4 minutes peak to peak)
			from -142 to -159 dbm.
	-142	090109	
	-151	090322	Signal varying -149 to -161 dbm.
	-155	091001	
		091420	Channel 2 is 95% in lock.
	-143	091534	
	-157	092527	
		092715	Out of lock.
		092750	In lock.
		092810	Out of lock.
		092830	In lock.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 24/0832 to 1703

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0832 to 1703, GM-4	-152	093354	
	-148	093503	Receiver out of lock. Tracking capsule.
		093624	In lock.
	-144	093717	Signal strength varying from -140 to -161.
		094645	Digital printer in receiver printing next to last
			number incorrectly.
	-150	095640	
		095935	AM DC amplifier going into oscillation.
		100449	Changing receiver frequency to obtain same
			frequency as Echo.
		100723	In lock. Believe this is carrier. Can lock on
			five frequencies.
	-153	101048	
	-152	101830	
		102040	Maser retuned.
	-142	102908	
		103344	Receiver on sideband.
		103534	In lock on carrier.
	-143	103745	
	-151	104118	Signal strength varying from -141 to -166.
		105200	Receiver apparently locked on sideband prior to
			100600. Now a good correlation between received
			frequencies of Echo and Pioneer Stations.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 24/0832 to 1703

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0832 to 1703, GM-4	-141	112748	
	-149	114050	
	-144	115400	Signal strength varying from -138 to -157.
	-140	121203	
		123144	Lost lock. Locked on sideband.
		123255	Relocked on capsule frequency.
	-153	123646	
	-148	124600	Varying from -140 to -157.
	-142	130910	
	-144	133232	Varying from -140 to -160.
		133957	Echo station manager advises that good-bad data
			switch be in bad position. So placed.
		135510	Locked on side lobe.
		135538	Back on capsule frequency.
	-140	141515	
	-151	143240	Varying from -140 to -155.
		144145	Locked on sideband.
		144242	Back on capsule frequency.
	-144	150543	
	-155	150738	Locked on sideband.
		150825	Back on capsule frequency.
	-150	151536	
	-150	153041	Varying from -142 to -160.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 24/0832 to 1703

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0832 to 1703, GM-4	-159	153850	
		153910	Out of lock.
		154056	Back on capsule frequency.
		155000	PDBL out of lock since 142000. Frequencies will be
			monitored and recorded at 15- to 20-minute intervals
			hereafter.
	-145	155730	
		155830	Out of lock.
		155850	Back on capsule frequency.
		161310	Out of lock.
		161352	Back on capsule frequency.
		162300	Receiver loop frequency log sheets started. Readings
			to be taken every 20 minutes.
	-150	162812	
		163520	Out of lock.
		163530	In lock.
	-157	163729	
		163810	Out of lock.
		163820	In lock.
	-146	164007	
		164417	Out of lock.
	-150	164550	In lock. Signal strength from -144 to -160.
	-160	165200	

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 24/0832 to 1703

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0832 to 1703, GM-4 ↓		165300	Out of lock.
	-151	165339	In lock.
		165650	Momentarily out of lock.
		165738	Servo degree off horizon.
	-151	170130	
		170313	Out of lock.
		170535	S/C below horizon.
		170743	Servo in aided track.
		173520	Post calibration started.

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		074850	Rcvr. starting search for transponder.
		075446	Data started recording.
		080000	Computer states commands are good.
		081900	Rcvr. going to 20-cps tracking filter.
		083109	Rcvr. sweeping at slower rate.
		083700	Rcvr. to manual sweep.
		090000	Rcvr. searching for capsule.
090040 to 122857, GM-4	-141	090040	Rcvr. in one-way lock on capsule.
		090200	Servo to autotrack.
		090248	Servo to aided track.
		090254	Out of lock.
	-147	090300	In lock. Antenna in slave mode.
	-147	090318	Signal strength varying due to S/C tumbling.
	-149	090424	
	-153	090447	
		090610	Servo to autotrack.
	-147	090643	
	-143	090716	
	-142	090739	
	-142	090817	
	-141	090830	
	-153	091010	
	-145	091500	Still tracking capsule.

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
090040 to 122857, GM-4	-153	091755	
	-149	091842	
		091858	Servo to slave mode. Rcvr to bad data.
	-143	092338	
	-150	092520	
	-151	092647	
		092717	Out of lock.
		092833	In lock.
	-144	093000	
	-152	093240	
		093430	Out of lock.
		093440	In lock.
	-141	094600	
	-155	095415	
	-142	100010	
	-154	100203	
	-155	100848	Apparently locked on a sideband prior to this time.
		101634	Out of lock.
		101648	Rcvr. in lock on sideband.
		101730	Rcvr. to acquisition.
		101749	In lock.
		102346	Momentary loss of lock.
	-145	102829	

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
090040 to 122857, GM-4	-144	102939	
	-151	103139	
		103312	Out of lock.
		103400	In lock.
		103430	Out of lock.
		103448	In lock.
	-144	104413	
		104530	Out of lock. Receiver falling in and out of lock
			approx. every 4 minutes.
		104601	In lock.
	-148	104648	
	-143	105150	
	-152	105300	
		112524	Rcvr. noise temperature was 180°K.
		113200	CEC recorder paper jammed.
	-157	113833	
		113900	CEC recorder operating.
		113910	Out of lock.
		114213	Signal seemed to fade and then came back.
	-145	114304	
		114430	CEC recorder off for check.
		114445	CEC recorder back on.
	-150	114600	

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
090040 to 122857, GM-4		115900	Out of lock.
	-146	120306	
	-151	122857	
		123005	Attempting to lock on transponder at 960.05 Mc.
		124640	Transmitter on and searching.
		130400	Transmitter off
130500 to 152500, GM-4		130500	Rcvr. to 960.25 Mc searching for capsule.
	-151	130510	In one-way lock.
		130800	Out of lock.
		130822	In lock.
	-144	130916	
	-142	132530	
	-155	132633	
	-160	133635	
	-154	134136	
		134306	Out of lock.
		134416	In lock.
	-156	134900	
		135531	Out of lock.
		135550	In lock on sideband.
		143500	Sanborn Recorder shut down. Only 1 operating
			channel. Channel 2 analog moved to CEC recorder.
	-145	143700	

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
130500 to 152500, GM-4		144200	Out of lock.
		144349	In lock.
		144600	Monitor machine off in communications.
		144900	Rcvr. to acquisition due to carrier dropping out and
			coming back on sideband.
		145140	In lock.
		145450	Out of lock. No signal.
		145745	In lock.
	-148	150130	Monitor machine on the line again.
	-155	150817	
		151845	Out of lock. No signal.
		151932	In lock.
	-143	152135	
	-146	152334	
		152500	Interference 40 db above noise level showing on
			analyzer.
		153000	Search for transponder until 160000.
		153100	Rcvr. on sideband unlocked.
		153200	Rcvr in lock. Weak signal.
		153300	Rcvr. to 960.05 Mc searching for transponder.
160400 to 170440, GM-4		160400	Rcvr. locked on capsule.
	-153	160541	
		160920	Out of lock. Receiver in and out of lock every four minutes.

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
160400 to 170440, GM-4		161016	In lock.
	-150	161500	
		162100	Rcvr. on sideband.
		162130	Relocked on capsule signal.
	-151	162900	
	-155	163050	Signal level decreasing.
	-145	163400	
	-155	163520	Momentary out of lock.
	-158	163658	
		163700	Out of lock.
	-158	163829	In lock.
	-148	163933	
	-146	163950	
	-145	164100	Signal steady.
		164240	Out of lock.
	-158	164327	In lock.
		164400	Out of lock.
	-162	164500	In lock.
		164509	Out of lock.
	-158	164545	In lock.
	-152	164630	
	-150	164643	
	-147	164710	

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
160400 to 170440, GM-4	-146	164726	
	-145	164800	
	-150	164900	
	-154	164926	
	-155	165101	
		165130	Rcvr. out of lock.
		165230	In lock.
		165255	Rcvr. out of lock.
		165312	In lock
	-158	165333	
	-153	165344	
	-153	165400	
	-148	165430	
	-146	165448	
	-149	165600	
		165625	Out of lock.
		165653	In lock.
	-158	165725	
	-152	165740	
	-152	165800	
	-154	165832	
	-157	165852	Rcvr. dropping lock.
		165916	Out of lock.

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 24/0900 to 1708

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
160400 to 170440, GM-4	-158	170000	In lock.
	-145	170221	
	-155	170330	
	-153	170440	
		170452	Out of lock due to horizon mask.
		170530	Rcvr. unable to lock on.
		170720	Lost signal. (Transponder never acquired during
			entire period).
		170727	Servo on aided track.
		170817	Instrumentation and data off the air. End of first
			track.
			Echo Station did not participate in second tracking
			period.

Table A-4. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Apr. 24/1352 to 25/0158

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1353 to 1500, GM-4	-151	135244	Acquired on 60-cps bandwidth, 10-sec AGC time
			constant, and 0.1-cps servo bandwidth.
	-154	140000	Servo to aided track.
	-151	140820	In lock and good data.
	-156	141000	
	-146	141500	
	-156	144203	Receiver lost lock momentarily.
	-145	150000	Begin transponder search.
	-148	153135	End transponder search. No success.
1559 to 1823, GM-4	-147	155847	Transfer receiver to another frequency. Channel 2
			telemetry lock is better.
	-147	160900	Receiver in and out of lock to 173257.
		173319	Acquired.
		173900	Change to non-destructive doppler count.
		180500	Format error discovered in doppler printout.
			Twenty-six minute non-destructive doppler lost.
		182251	Out of lock. In and out of lock until 200000 when
			transponder search began. Signal level generally
			-154 dbm but rose to -148 and fell to -157 dbm.
			Longest in lock period was 8.3 minutes.
		200000	
		203000	End transponder search. No success.
(A)		203121	Reacquire capsule.

(A) 2031 to 0100, GM-4

Table A-4. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Apr. 24/1352 to 25/0158

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2031 to 0100, GM-4		010000	Several brief periods of loss of lock occurred since
			2031. Signal levels read as varying from -139 to
			-151 dbm and averaging -144 dbm. Check of para-
			metric amplifier gain at this time however shows
			gain 8 db high.
		010200	Begin transponder search.
		013000	End transponder search. No success.
0131 to 0159, GM-4		013100	Searching for capsule.
		013631	Acquired.
	-148	013754	
	-156	014903	
		015859	End of tracking period. Mometary loss of lock
			occurred from 0137 until the end of the tracking
			period.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 24/2121 to 25/0925

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		160000	Countdown started.
		211200	Countdown completed.
		212130	Signal first heard (capsule).
2121 to 0925, GM-4		212135	Receiver in lock.
		212330	Receiver in and out of lock.
		212848	Receiver in and out of lock.
	-157	212908	Receiver in lock, servo auto, good data
		214200	Signal levels varying from threshold to -141 dbm.
			Receiver out of lock a total of about 5 minutes out of
			last 11 minutes.
		214253	Channel 2 in lock.
		214900	Changed receiver AGC to 300 secs.
		222420	Receiver checking if they are on correct signal.
		222535	Receiver back in lock, servo auto, good data.
		230243	Channel 2 frequency 559 cycles/sec.
	-149	002500	Receiver still in and out of lock. Out of lock for
			periods of 10 seconds to three minutes. In lock for
			periods of from 20 seconds to 6 1/2 minutes.
		030900	Receiver AGC changed to 10 secs.
		062000	Stop capsule tracking. Receiver still alternating
			periods of in lock and out of lock.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 24/2121 to 25/0925

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
2121 to 0925, GM-4			Start search for transponder
		065000	Reacquired capsule. No results in transponder
			search.
		091050	Antenna in western prelimits. Receiver continued
			to have periods of in and out of lock.
		092511	Receiver out of lock. Spacecraft below horizon mask.

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		084000	Tape recorder started.
0847 to 0930, GM-4		084730	Receiver locked.
	-157	084930	Good-bad data switch in good position.
		085220	In 60-cycle bandwidth.
		085330	Out of lock.
		085345	In lock.
	-153	085418	Good data.
		085645	Out of lock.
	-156	085715	In lock. Servo in aided track during tracking period.
			Computer unable to provide slave track data.
		090005	Out of lock.
	-157	090033	In lock.
	-160	091415	
		091824	Out of lock.
		091850	In lock.
	-155	092231	
		092900	Out of lock.
		092925	In lock.
	-164	093000	
		093120	Out of lock. Will search for bus transponder for
			30 minutes.
		094037	No recording due to extreme noise in signal.
	-150	094830	Signal varying to -166.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		100000	End transponder search.
1000 to 1300, GM-4		100009	Max. signal strength found when tracking .2° ahead
			of predictions in hour angle; .1° ahead in declination.
		100635	In lock. Lock indications on tapes between 0930 and
			1000 were due to maser personnel putting signal on
			for short period.
		100950	Out of lock to check shift in frequency.
		101000	Back in lock.
		101350	Good-bad data switch was in wrong (bad) position.
		101420	Out of lock.
		101510	In lock.
	-157	101600	
	-154	101853	
		102250	Position of counter switch was cause of frequency
			error reading at 100950.
	-152	102614	
		103150	Out of lock.
		103208	Receiver back in lock.
	-153	103401	
		103530	Out of lock.
		103540	In lock.
	-157	103611	
	-157	103830	

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1000 to 1300, GM-4		104000	Out of lock.
		104240	In lock.
	-156	104340	
	-148	104739	
	-156	105704	
		105920	Out of lock.
		105945	In lock.
	-153	110145	
	-149	110910	
	-168	111038	
		111012	Out of lock.
		111040	In lock.
	-157	111139	
	-152	111511	
	-153	111640	
		112050	Out of lock.
		112105	In lock.
	-152	112242	
	-167	113759	
		113800	Out of lock.
		113820	In lock.
	-154	114000	
	-156	114850	

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1000 to 1300, GM-4	-156	115445	
	-151	115819	
	-155	121605	
		122350	Out of lock momentarily.
	-149	122624	
	-153	123020	
		123402	Out of lock.
		123420	In lock.
	-156	125743	Data switch changed from good to bad position for
			remainder of tracking period.
		130017	Out of lock. Begin search for transponder.
		131344	No contact with bus frequency.
		133000	End transponder search. No success.
1332 to 1730, GM-4		133139	In lock on capsule frequency.
	-153	133237	
		133700	Maser retuning completed. System temperature
			before, 56°K; after, 54°K.
	-147	134300	
		135810	Out of lock.
		135820	In lock.
		140518	Out of lock.
		140528	In lock.
		141248	Out of lock.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1332 to 1730, GM-4	-151	141526	In lock.
		141717	Servo and receiver attempt to peak up tracking merit.
	-150	142450	
		142555	Out of lock.
	-155	142605	In lock.
		144314	Out of lock.
	-149	144345	In lock.
		144627	Out of lock.
		144651	In lock.
	-146	145620	
	-152	145810	
		150056	Out of lock.
		150115	In lock.
		151036	Out of lock.
		151049	In lock.
	-156	151736	
	-150	151910	
		152145	Out of lock.
		152156	In lock.
		153854	Out of lock.
		153905	In lock.
	-150	154358	
		155640	Out of lock.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1332 to 1730, GM-4		155707	In lock.
		160652	Out of lock.
		160707	In lock.
	-150	160840	
		161715	Out of lock.
		161738	In lock.
	-156	162032	
	-151	162101	
	-147	162930	
		163336	Out of lock.
		163438	In lock.
	-148	164331	
		165214	Out of lock.
		165238	In lock.
		170107	Out of lock.
		170245	In lock.
		170644	Out of lock.
	-156	170942	In lock.
		171302	Out of lock.
	-158	171326	In lock.
	-148	171807	
		171955	Out of lock.
	-156	172005	In lock.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 25/0847 to 1748

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1332 to 1730, GM-4		172317	Out of lock.
		172329	In lock.
	-148	172513	
		172627	Out of lock.
	-153	172707	In lock.
	-151	172903	
		173017	Ceased tracking capsule.
		173018	Begin search for transponder.
		173620	Servo reports HA 1 degree off horizon limit.
		174820	End transponder search. No success.
			End of track. No telemetry received.

Table A-4. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Apr. 25/1423 to 26/0213

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
1423 to 1433, GM-4	-155	142300	Acquire capsule frequency.
		142555	Out of lock.
		142628	In lock.
	-157	142840	Out of lock.
		142948	In lock.
	-158	143300	In and out of lock until 150300.
		150332	Begin search for transponder signal.
		153337	End search for transponder. No success.
1535 to 1957, GM-4		153508	In lock on capsule.
	-157	153700	
		153844	Out of lock.
		154100	In lock.
	-155	195642	In and out of lock since 154200.
		195926	Begin search for transponder signal.
		203000	End search for transponder. No success.
2031 to 0128, GM-4	-151	203035	Reacquire capsule signal.
		203410	Out of lock.
		203708	In lock.
	-149	012755	In and out of lock since 25/203800.
		013000	Begin search for transponder signal.
		020000	End search for transponder. No success.
(A)	-157	020150	In lock on capsule frequency.
		020300	Out of lock.

(A) 0202 to 0213. GM-4

Table A-4. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Apr. 25/1423 to 26/0213

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0202 to 0213, GM-4		020344	In lock.
	-149	021230	In and out of lock since 020500.
		021306	End of 3rd pass. Antenna at prelimits.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Apr. 25/2140 to 26/0932

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		160000	Start countdown.
		201000	Snap-ons completed.
		213510	Signal first heard.
2140 to 2233, GM-4	-152	214013	Receiver in lock, servo auto, good data.
		214100	Channel 2 95 percent in lock.
	-148	214153	
		214347	Receiver out of lock to check sidebands.
		214810	Receiver in lock. Channel 2 in lock.
	-149	221450	Receiver generally in lock, but brief out-of-lock
			periods of as great as 20 seconds.
	-145	223300	
		230800	Searching for transponder for 30 minutes.
2338 to 0300, GM-4		233800	No success on transponder, back to capsule.
	-145	233920	Receiver in lock on capsule. Servo auto.
		030000	Receiver still generally in lock. Occasional out-
			of-lock periods of less than a minute.
		030300	Begin search for transponder.
0303 to 0333, GM-4		033248	No results. Reacquired capsule transmitter.
			Receiver still out of lock for brief periods.
		070030	Search for transponder.
0730 to 0932 GM-4		073000	No results. Reacquired capsule transmitter. Re-
			ceiver still out of lock for occasional brief periods.
		093055	Antenna in prelimits.

Table A-4. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: APR. 25/2140 to 26/0932

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
(A) ↓		093208	Receiver out of lock. Spacecraft over western horizon.

(A) 0732 to 0932, GM-4

Table A-4. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Apr. 26/083300 to 124754

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		080800	Antenna at acquisition point.
		080150	Receiver starts search for capsule.
0833 to 0952 GM-4	-158	083300	Receiver locks on capsule frequency. Servo in slave
			mode with offsets being used as required. Signal
			strength averaging -152 dbm ± .5 db. Receiver out
			of lock about every 4 minutes.
		095200	Attempt made to acquire transponder.
1025 to 1248, GM-4	-158	102500	Receiver returns to capsule search. Transponder
			search unsuccessful. Signal strength averaging
			-155 dbm ± 5 db with intermittent dropouts.
		114747	Data sampling rates changed to 1 per 10 sec.
			Acquisition camera of TV system turned on.
	-151	124754	The instant the leading edge of the Moon crossed the
			center of the TV screen the receiver reported an
			out-of-lock condition.
		133100	Mission concluded after searching for probe at the
			other edge of the Moon.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 26/084600 to 124747

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
		083630	Tape recorder started.
		083850	Data on using 60-second sample rate, 10-second
			count interval.
		084245	Servo in slave.
0846 to 0941, GM-4		084600	Receiver locked on capsule frequency.
		084645	Out of lock.
		084800	In lock.
	-156	084900	
		085000	Servo changed bandwidth from .10 to .05.
		085226	Channel 2 good lock.
	-155	085355	
		085700	Out of lock.
		085714	In lock.
	-155	085850	
	-158	085946	
		090100	PDBL out of lock momentarily.
		090112	Good-bad data switch to be off remainder of pass.
	-155	090416	
		090700	Out of lock.
		090745	In lock.
	-150	090111	
	-163	091017	
	-152	091158	

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 26/084600 to 124747

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0846 to 0941, GM-4	-152	091435	
		091725	Out of lock.
		091800	In lock.
		092000	PDBL out of lock.
		092010	PDBL back in lock.
	-153	092238	
		092415	Receiver out of lock.
		092519	In lock
	-157	092637	
	-154	093001	
	-154	093036	
	-162	093252	
	-159	093324	
	-152	093710	
	-160	904050	
		094200	Out of lock. Attempting to track bus transponder.
		094700	Transponder search unsuccessful.
		094742	Receiver searching for capsule frequency.
0949 to 1248, GM-4	-151	094840	In lock on capsule.
	-154	095201	
	-154	095521	
	-149	095702	
	-156	100115	

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 26/084600 to 124747

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0949 to 1248, GM-4	-156	100807	
	-149	101115	
		101220	Receiver out of lock. PDBL loop out of lock.
		101221	Back in lock. PDBL in lock.
		101345	Receiver out of lock.
		101400	In lock.
		101401	Receiver out of lock. PDBL out of lock.
		102710	Receiver in lock. PDBL in lock.
	-158	102806	
		103000	Good-bad data switch to be used to indicate doppler
			data condition.
	-160	103420	
	-153	103710	
	-152	103840	
	-156	104040	
	-151	104510	
		104829	PDBL out of lock.
		105110	PDBL in lock.
		105312	Were not getting enough drive out of Gertsch to
			doppler loop. Removed 50-ohm load resistor.
	-152	105404	
	-153	110123	
		110650	Receiver out of lock.

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 26/084600 to 124747

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0949 to 1248, GM-4		110720	In lock.
	-157	110810	
		110905	PDBL out of lock.
		111030	PDBL in lock.
		111400	Goldstone manager requested that the 30-mc PDBL
			frequency be monitored closely during the last hour.
		111900	PDBL out of lock.
		112259	PDBL in lock.
	-161	112909	
	-153	113116	
	-156	113520	
	-148	113915	
		114200	Changed sampling rate to 10-sec interval.
	-160	114410	
	-156	115000	
	-150	115315	
	-152	115545	
	-152	115923	
		120120	Receiver out of lock.
		120130	In lock.
		120830	Out of lock.
		120848	In lock.
	-154	121430	

Table A-4. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Apr. 26/084600 to 124747

TRACKING CONDITIONS	SIG. STR. (dbm)	TIME (GMT)	REMARKS
0949 to 1248, GM-4	-152	122114	
		122204	Receiver out of lock.
		122211	In lock.
	-154	122520	
	-151	122737	
	-154	122950	
	-150	123340	
		123400	Receiver switched to 20-cps bandwidth and held lock
			satisfactorily.
	-156	123448	
	-153	123548	
	-154	123650	
	-155	123800	
	-150	124001	
	-162	124507	
	-150	124655	
		124747	Out of lock. Abrupt loss of signal.
		124750	Searching for capsule. No success.
		133210	End of mission.

V. *RANGER 5* OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-29–A-35) for the *Ranger 5* space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary in the form of edited station logs. Translations of the code assignments used in Table A-5 to identify the space communication stations of the DSIF are contained in Section I of this appendix. Table A-5 also contains a special coding for the station ground modes of operation, real time commands, and stored commands, as follows:

Ground station modes

GM-1 – Tracking the transponder signal in the two-way mode, obtaining angles, telemetry, and two-way doppler. This mode was possible at DSIF 1, 3, 4, and 5.

GM-2 – Listening for the transponder signal in the two-way mode, obtaining telemetry and two-way doppler. This mode was possible at DSIF 3, 4, and 5.

GM-3 – Tracking the transponder signal in the one-way mode, obtaining angles, telemetry, and one-way doppler. This mode was possible at DSIF 1, 3, 4, and 5.

GM-4 – Listening for the transponder signal in the one-way mode, obtaining telemetry and one-way doppler. This mode was possible at DSIF 2, 4, and 5.

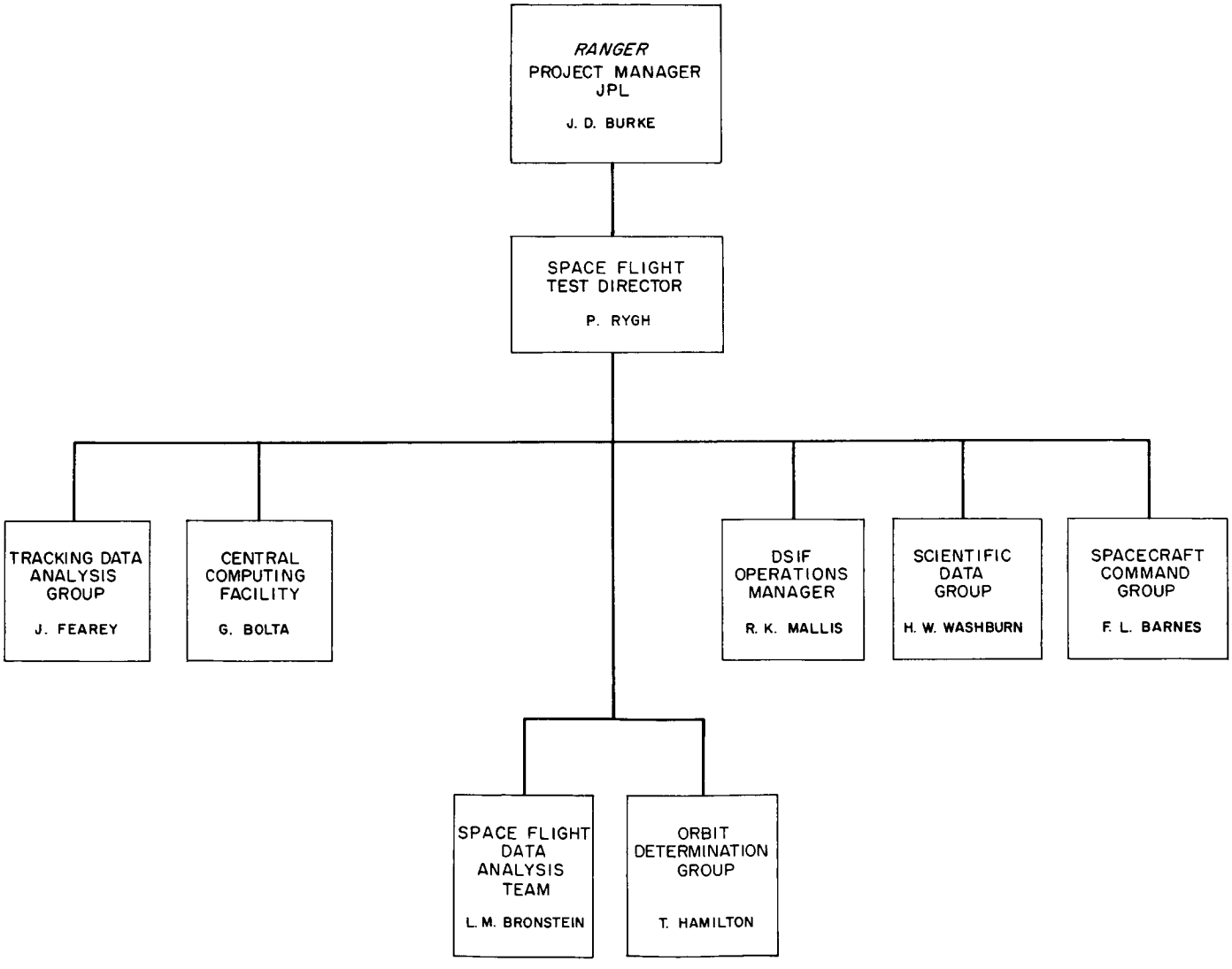


Fig. A-29. Space flight operations organization for *Ranger 5*

GM-5 – Listening for the transponder signal in the two-way mode, obtaining telemetry and two-way doppler. This mode required the coordination of equipment at DSIF 2 and 3.

GM-6 – Transmitting only to the transponder. No signal is received and no doppler obtained. This mode was possible at DSIF 3 and 5.

GM-7 – Listening for the capsule beacon signal and obtaining capsule telemetry. This mode was possible at all DSIF stations except DSIF 0 and DSIF 1.

Real time commands

RTC-0 – Clear.

RTC-1 – Roll override.

RTC-2 – Antenna hinge angle override.

RTC-3 – Antenna switchover.

RTC-4 – Begin midcourse maneuver.

RTC-5 – Telemetry mode change.

RTC-6 – Begin terminal maneuver.

RTC-7 – Turn on altimeter power.

Stored commands

SC-1 – Midcourse maneuver roll duration.

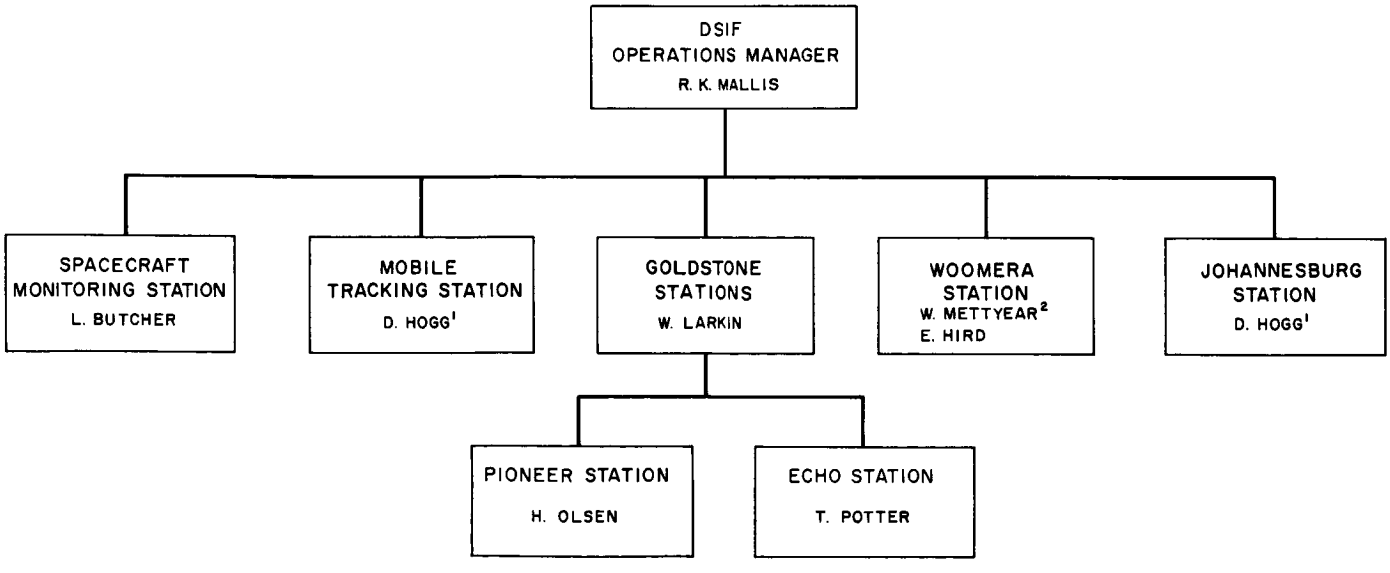
SC-2 – Midcourse maneuver pitch duration.

SC-3 – Midcourse maneuver velocity increment.

SC-4 – Terminal maneuver first pitch duration.

SC-5 – Terminal maneuver yaw duration.

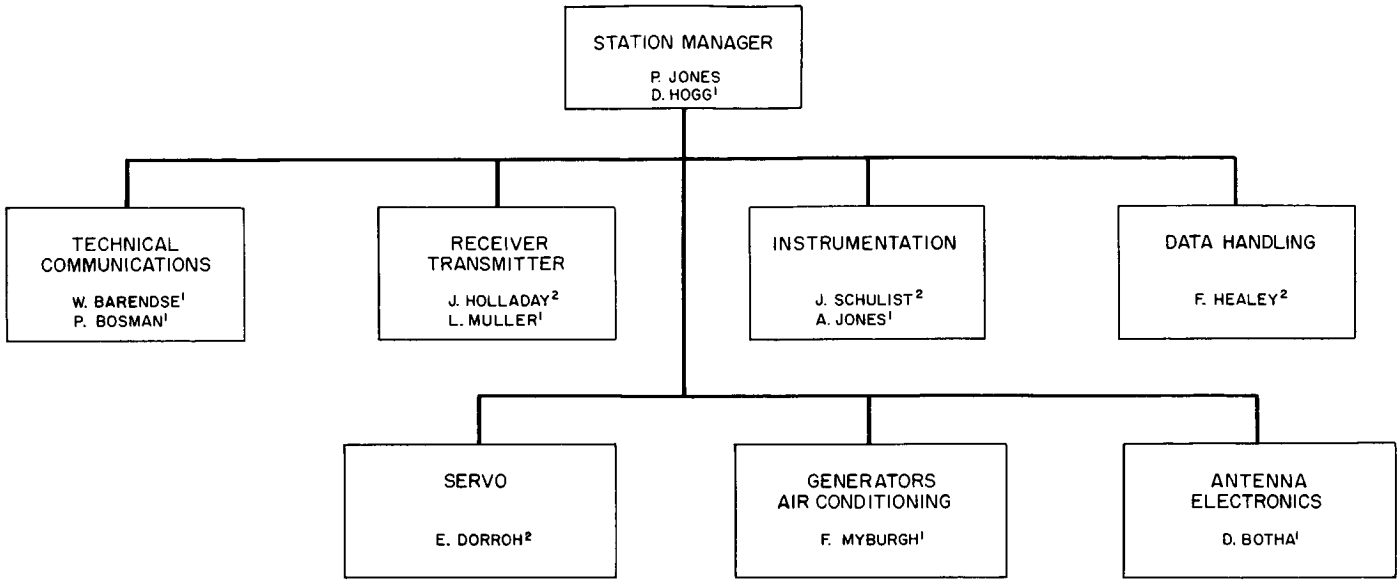
SC-6 – Terminal maneuver second pitch duration.



[1] NATIONAL INSTITUTE OF TELECOMMUNICATIONS RESEARCH, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF THE REPUBLIC OF SOUTH AFRICA

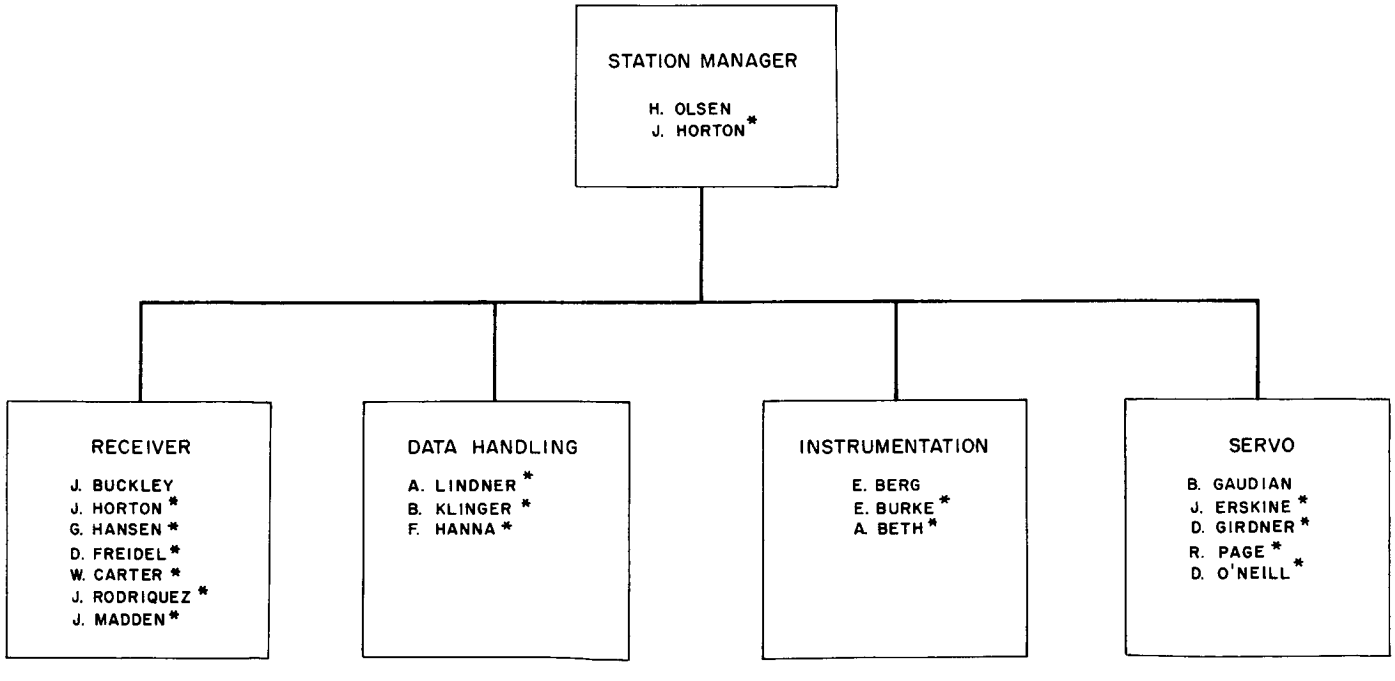
[2] WEAPONS RESEARCH ESTABLISHMENT OF THE DEPARTMENT OF SUPPLY, COMMONWEALTH OF AUSTRALIA

Fig. A-30. DSIF operations organization for *Ranger 5*



[1] NATIONAL INSTITUTE OF TELECOMMUNICATIONS RESEARCH, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF THE REPUBLIC OF SOUTH AFRICA
[2] COLLINS RADIO COMPANY
[3] BENDIX FIELD ENGINEERING CORPORATION

Fig. A-31. Mobile Tracking Station organization for *Ranger 5*



* BENDIX FIELD ENGINEERING CORPORATION

Fig. A-32. Goldstone Pioneer Station organization for *Ranger 5*

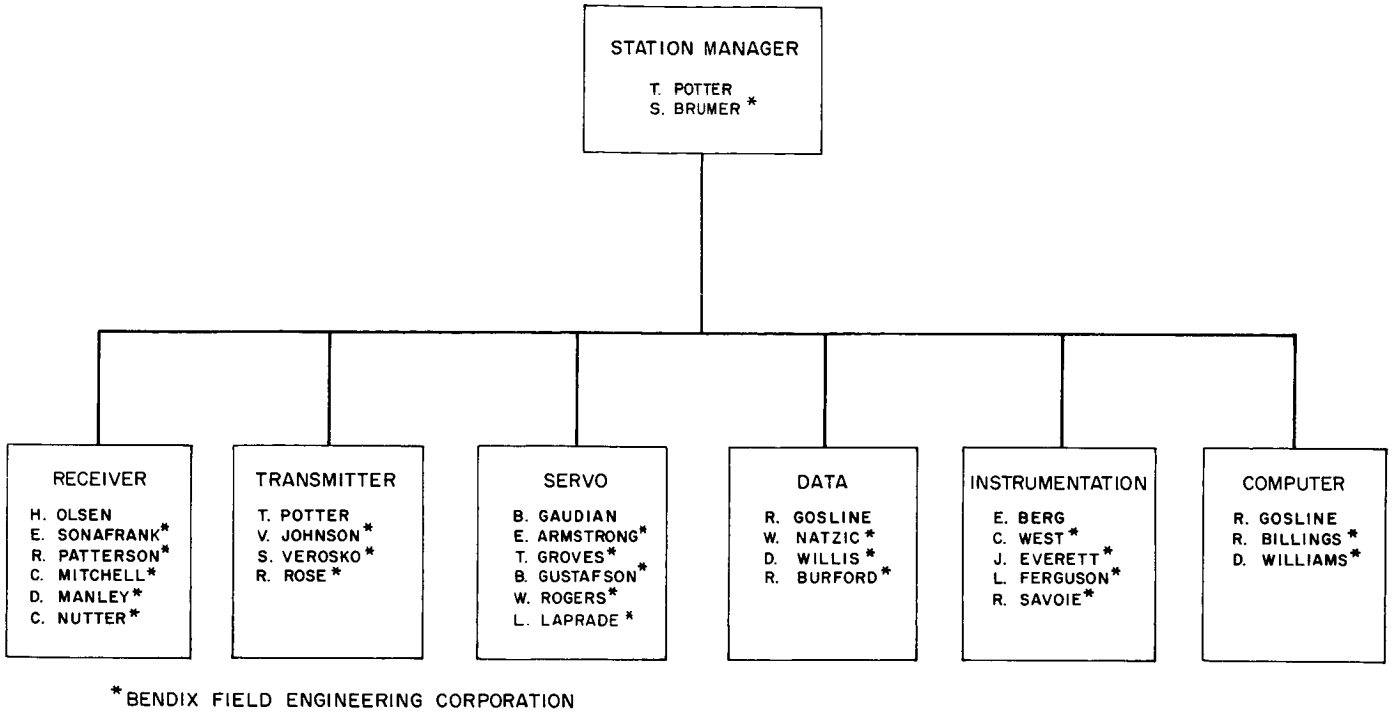


Fig. A-33. Goldstone Echo Station organization for *Ranger 5*

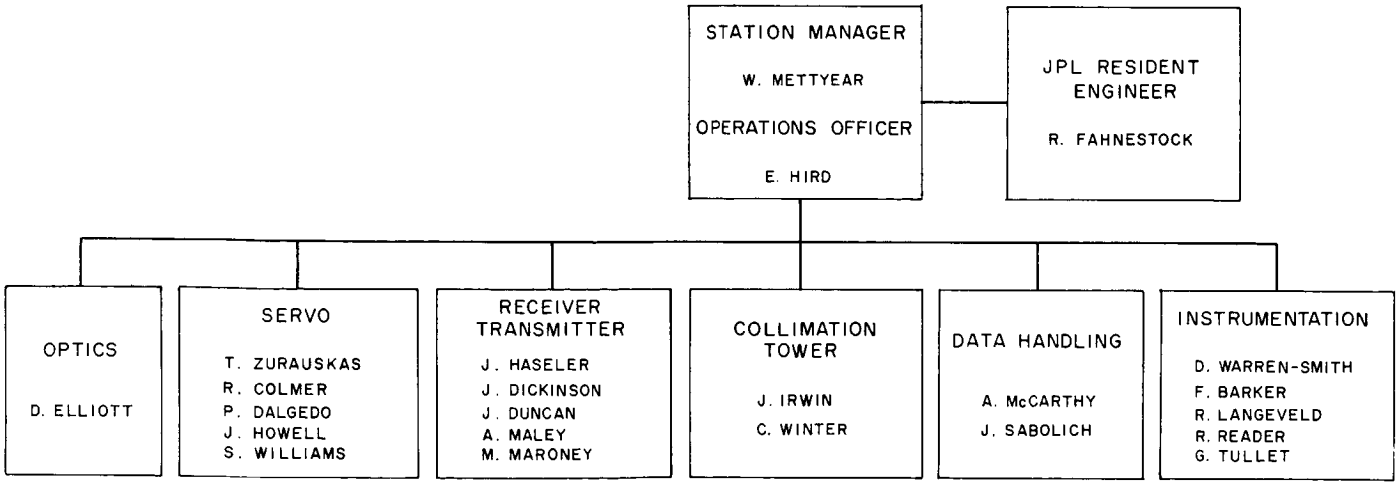


Fig. A-34. Woomera Station organization for *Ranger 5*

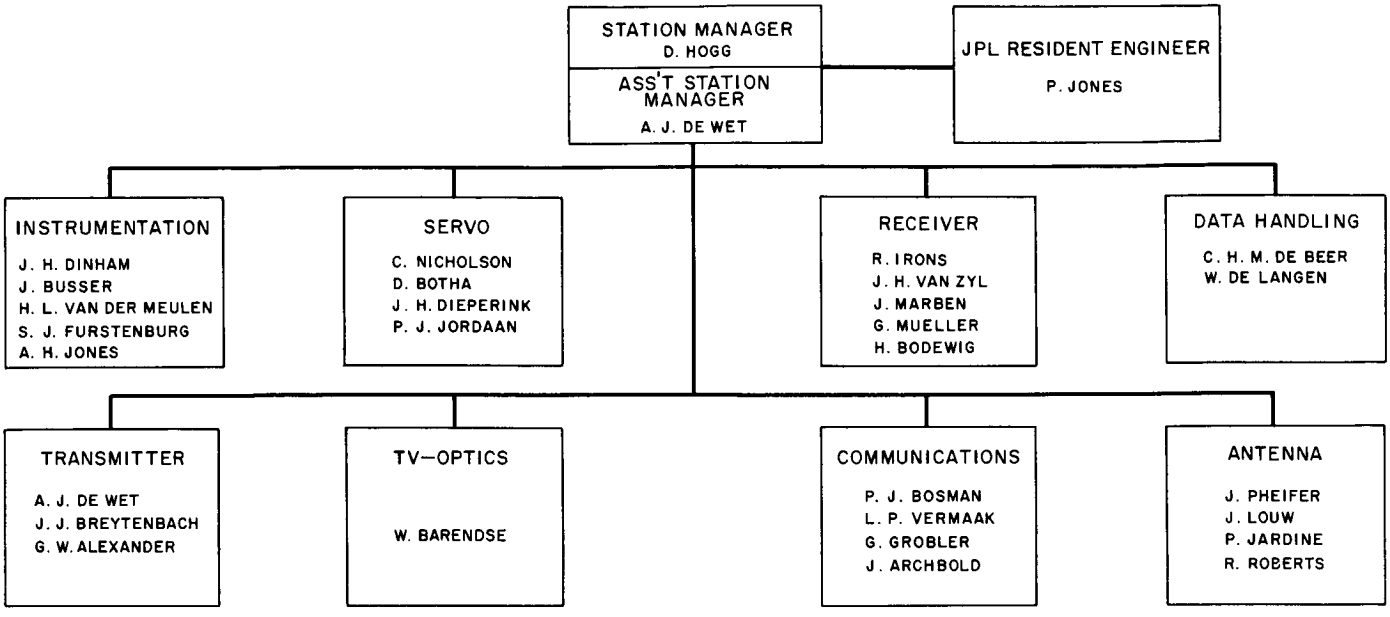


Fig. A-35. Johannesburg Station organization for *Ranger 5*

Table A-5. *Ranger 5* tracking operations summary

STATION: DSIF-1

VIEW PERIOD: Oct. 18/1730 to 18/1737

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0900	Equipment and personnel ready.
		0915	Communications checks complete.
		0920	Pedestal level complete.
		0930	Toggle tests complete.
		0935	Target and telescope checks complete.
		1002	Boresight No. 1 complete.
		1015	Servo adjustments complete.
		1140	Radio adjustments complete.
		1155	Radio/data doppler checks complete.
		1155	Radio/telemetry calibrations complete.
		1337	T-215 Report sent.
		1355	Radio/telemetry calibrations complete.
		1400	Communications established on RA-30
			teletype circuit.
		1420	Auto mode gain and snap on tests complete.
		1435	Pedestal level/reference target checks
			commencing.
		1450	Pedestal level/reference target checks
			complete.
			Boresight No. 2 started.
		1447	T-135 Report sent.
		1514	Boresight No. 2 complete.
		1558	T-70 Report sent. Pretrack report sent.
		16590	Lift-off.
		1710	AGC recalibration completed.
		1716	Look angles received.
		172407	Tele. recorders on.
		172930	Data system on and sampling.
↑	-104	173028	Acquisition. Two-way. Autotrack.
1730 to 1737,		173029	Spacecraft elevation 1.0 degree.*
GM-1		173120	Bias in, VCO frequency -296682112, 10-second
			count.
↓		173045	All telemetry channels in lock.

*Read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Oct. 18/1730 to 18/1737

Servo Bandwidth ______ cps

Receiver Bandwidth ______ cps

AGC Time Constant ______ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1730 to 1737, GM-1		173529	Spacecraft elevation 2.4 degrees.*
		173707	Receiver out of lock. End of pass.
		173745	Tele. recorders off.

*Read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 18/1732 to 18/1735

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		165907	Lift off.
		1706	Receiving garbled predictions.
		1717	Receiving look angles from AMR.
		1722	Started tape recorder A.
		172930	Oscillograph on.
↑	-105	173152	Receiver in lock. Using acquisition aid
			antenna.
		173220	In auto.
		173250	Receiver to 20 c/s bandwidth.
		1733*	Approximate time spacecraft above antenna
			limits.
		173340	Auto on both axes.
1732 to 1735,		173400	Receiver out of lock.
GM-3		173412	In lock.
		173420	Servo auto. Good data.
		173440	Out of lock.
		173447	In lock.
		173450	Servo in lock.
		1735*	Spacecraft below land mask.
↓		173530	Receiver out of lock.
		173610	Stopped taking samples.
		1739	Acquisition report sent.
		1743	Stopped tape recorder A.
		1752	Sent station summary.
		1850	Carrying out AGC calibrations.
		1948	Focus supply of klystron failed, replaced by
			spare power supply.

*Approximate times read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746Z to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		1735	Antenna at acquisition point 85 degrees HA
			352.2 degrees Dec in acquire mode. Data
			sampling, telemetry recording and receiver
			scanning.
		1741	Started transmitting tracking data.
	-137	174537	First RF lock. Telemetry channels locked up.
			Started transmitting telemetry program S.
		1746	Spacecraft above antenna limits.
	-124	174700	Antenna mode switch to track followed by
			signal strength increase to -102 dbm. Channel
			B-2 blips (B-2-1 and B-2-2).
1747 to 1835 GM-3	-110	174713	Servo to auto.
		174717	Unusual small spikes on dynamic phase error
			channel noticed. Repetition rate about 2 per
			second. Observed intermittently over 15-
			second period.
	- 98	174727	Snap on complete.
		174800	Transmitter on. Doppler mode changed to
			7-figure destructive.
	- 99	174803	Receiver out of lock 6 seconds.
		174808	Receiver in lock two-way.
	-101	174913	Receiver out of lock.
		174922	Receiver in lock one-way.
		174928	Receiver out of lock.
		174940	Receiver in lock one-way.
	-101	175000	B-2-1 blip.
		175025	Low speed Dec -0.05 c/s at 175250.
	-116	175315	Signal strength fluctuating with period of 45
			seconds. Peak-to-peak variation about 10 db.
	-116	175332	Receiver out of lock. Servo to aided track.
			Antenna misaligned (noise temperature
			indication gradually reduced as signal was lost).
		175423	Antenna mode to acquire.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746Z to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1747 to 1835, GM-3	-146	175548	Receiver in lock one-way. Servo to auto.
	-146	175714	Antenna mode track attempts.
	-141	175845	Antenna mode successfully to track position
			followed by signal strength increase to -115 dbm.
		175819	Receiver out of lock.
		175824	Receiver in lock one-way.
	-125	175936	Receiver out of lock intermittently for 55
			seconds. Finally in one-way lock.
		180030	Antenna mode to acquire following suspected
			side lobe main beam acquisition.
		180100	Telemetry teletype transmissions garbled.
			Transmission restarted.
	-137	180201	Antenna mode successfully to track position
			followed by signal strength increase to -110 dbm.
	-107	180300	Receiver out of lock.
		180303	Receiver in lock one-way.
		180335	Receiver out of lock. Reacquired one-way.
		180405	Tried low-speed HA.
		180418	Returned to high-speed HA.
	-108	180458	Receiver out of lock intermittently for 55
			seconds. Reacquired one-way.
	-107	180800	Receiver out of lock intermittently for 70
			seconds. Two-way acquisition regularly obtained.
			Final result one way.
	-109	181010	Low-speed HA -0.05 c/s at 181140.
	-109	181042	Receiver out of lock.
		181050	Receiver in one-way lock.
	-107.5	181300	Signal strength very steady with only slight
			slow wander. Unusual blips on HA and Dec
			channels. (This also occurred at 181300).
			Channel 4 telemetry became noisy.
		181327	Receiver out of lock.
		181337	Receiver in lock one-way.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746Z to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1747 to 1835, GM-3	-107	181400	Noise gone from channel 4 telemetry. At
			insistence of Net Control servo to high speed
			both axes with corresponding degradation in
			angle tracking.
	-107	181525	Servo to low speed following permission by Net
			Control for use of local judgment.
	-107	181546	Receiver out of lock intermittently for 43
			seconds. Reacquired one-way.
		181639	HA and Dec to 0.05 c/s.
	-108	181730	Receiver out of lock intermittently for 40
			seconds. Final lock one-way.
	-109	181855	Receiver out of lock.
		181900	Receiver in lock one-way.
	-108	182125	Receiver transient. Reduction in dynamic
			phase error.
	-108	182202	Receiver out of lock intermittently until
			182625. Final lock - one-way.
		182600	Antenna at unstable point (structural balance)
			359 Dec 356 HA.
	-109	182745	Receiver out of lock.
		182750	Receiver in lock one-way. Increase in dynamic
			phase error.
	-110	182917	Receiver transient.
	-110	182945	Receiver transient.
	-110	183000	Receiver out of lock.
		183005	Receiver in lock one-way with increase in
			dynamic phase error.
	-110	183400	Blips in HA and Dec - see report at 181300.
	-110	183507	Receiver out of lock.
GM-1		183530	Receiver in lock two-way.
1835 to 1907, GM-1		183851	First good data sample.
	-111	184423	Receiver transient.
	-111	1847	HA hitching for 90 seconds.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746 to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1835 to 1907, GM-1	-111	184848	Receiver transient.
	-110	185405	Receiver transient.
	-112	190011	Receiver out of lock. Sudden disappearance of
			transponder signal.
		190110	Quick lock onto capsule.
		190355	Quick lock onto capsule.
		190743	Transmitter off.
		190946	Intermittent capsule lock to ensure capsule
			carrier lock.
1912 to 1918, GM-7	-137	191155	Receiver locked on capsule carrier. Servo
			to auto.
		191210	HA and Dec to 0.025 c/s.
		1918	Channel 2 telemetry 556.7 c/s.
	-137	191451	Data sample rate changed to once per 10
			seconds. One second destructive doppler.
		191815	Receiver out of lock. Capsule search started.
		191951	Data sample rate changed to once per minute.
		192017	Momentary transponder lock.
1923 to 1928, GM-3 (A)	-116	192244	Receiver in lock one-way. Servo in auto.
		192511	Doppler changed to 10-figure cumulative count.
	-114	1927	Transmitter on. 64 watts forward power.
		192827	Receiver out of lock.
1929 to 2335, GM-1	-115	192835	Receiver in lock two-way.
		192827	Receiver out of lock for 6 seconds.
		193151	Doppler changed to 7-figure destructive count.
	-114	193700	
		193407	Receiver out of lock for 11 seconds.
		194007	Receiver out of lock for 10 seconds.
	-113	194100	
	-115	195907	Telemetry transmission fault. Declination
			hitching.
	-115	200200	All systems functioning normally.

(A) 1923 to 1928 GM-3 (intermittently).

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746 to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1929 to 2335, GM-1	-115.5	201900	Telemetry program C transmitted in place of
			program S.
		201913	Receiver out of lock.
		201915	Receiver in lock on sideband.
		202000	Receiver in lock on carrier.
		202211	Transmitter VCO drifting rapidly due to
			unscheduled variation to air conditioning
			parameters. Drift rate increasing to about
			1.6 cycles per second per minute.
	-116	203900	
		204600	Signal level falling slowly.
	-117.5	205900	Signal fell about 3 db - gradually returning to
			earlier level.
	-117.5	2100	Transmitter VCO tending to stabilize. Drift
			rate down to less than 0.4 cycles per second
			per minute.
		212135	Channel B-2-1 blip accompanied by Channel 8
			activity.
		212532	Another gamma ray readout on Channel 8.
			Becomes regular event.
		213135	Telemetry program D transmitted in place of
			program C.
	-116.5	2139	
	-118.5	2159	
	-119	2219	
	-120.5	2239	
		2246	Receiver out of lock - Joburg acquisition (?).
		2247	Doppler mode switch to pseudo two-way.
			Doppler count 10-figure cumulative. Good/bad
			data switch (GBDS) at bad awaiting confirmation
			of Joburg condition.
	-125	224904	Receiver in lock. Transmitter still on at
			request of Net Control.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746Z to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1929 to 2335, GM-1		2250	All discriminators in lock.
	-120.5	2259	
		230751	Data format returned to 7-figure destruc-
			tive doppler. Doppler mode switch to two-way.
		230920	Good/bad data switch to good on permission of
			Net Control. This was improper use of the
			GBDS since Joburg two-way attempts could
			invalidate the doppler without knocking the
			receiver out of lock. See data sample at
			232851.
1929 to 2329, GM-1		2313	Sticky clutch in Dec. Corrected within 2
			minutes.
	-120.5	2319	
		232845	Receiver transient.
		232930	Receiver out of lock.
		232936	Doppler mode switch to pseudo two-way.
			GBDS in bad.
		232941	Receiver in lock.
		2335	Data format changed to 10-figure cumulative.
2337 to 0114, GM-3		233702	First good pseudo two-way data.
	-120	2339	
		2340	Transmitter off. CEC oscillograph trace
			identification system failed. No trace
			identification for remainder of pass.
		234811	Telemetry program C transmitted in place of
			telemetry program D.
		235045	Channel B-2-1 blip.
	-120	2359	
	-119	0001	Alerted by Net Control to monitor channel B-20
			for stored commands. Channel B-20 found to
			be biased off oscillograph.
	-120.5	0039	
		0051	Channel B-20 recalibrated.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746Z to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
2337 to 0114, GM-3		005235	Receiver out of lock. Reason not known.
			Servo reacquired on side lobe.
	-120.5	010202	Servo back in good autotrack. Telemetry data
			transmission stopped on request.
		010342	B-20 stored command 25-3777-1. Channel
			B-2-1 blip.
		010402	Data sample rate changed to once per second
			with alternate count destructive doppler. Ten-
			figure doppler count left unchanged.
		010540	B-20 stored command 35-3777-1.
		010750	B-20 stored command 03-1451-1.
		011340	Receiver out of lock, looking for capsule.
0114 to 0121, GM-7		011348	Receiver in lock on capsule.
		011507	Good/bad data switch (GBDS) to bad. Poor
			autotrack.
	-148	011622	
	-150	011903	Good/bad data switch (GBDS) to good. Telem-
			etry data transmission recommenced.
		012043	Receiver out of lock, looking for transponder.
0122 to 0148, GM-3		012214	Receiver in lock on transponder.
		012958	Receiver out of lock for 3 seconds.
		013140	Receiver out of lock for 5 seconds.
		0133	Accelerometer pulses observed on telemetry
			channel 8.
		013402	Data sample rate changed to once per minute
			with 7-figure cumulative doppler.
			Operator error.
		013912	Channel B-2-1 blip.
		014336	Receiver out of lock for 7 seconds.
		014500	Gertsch out of lock since 010620 - power
			switch was knocked at floor level while taking
			1-second samples. Gertsch reset.

Table A-5. (Cont'd)

STATION: DSIF-4 - Woomera

VIEW PERIOD: Oct. 18/1746Z to 19/0220Z

Servo Bandwidth 0.2 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
0122 to 0148, GM-3		014545	Receiver suspects sideband lock. Reacquired
			on carrier at 014600.
		014720	Receiver out of lock for 20 seconds.
		014800	Receiver out of lock at threshold.
		015400	Data sample rate changed to once per second
			with 7-figure destructive doppler count.
			Secondary punch set up at once per 10 seconds.
		015700	Start capsule search.
0158 to 0220, GM-7	-153	015832	Receiver in lock on capsule.
		020100	Both magnetic tapes ran out.
		020329	Fairly certain of capsule carrier lock. Good/
			bad data switch (GBDS) to good.
	-150	021100	
	-144	021200	
	-142	021330	
	-148	021400	
	-151	021422	
	-157	021510	
	-155	021540	
	-151	021810	Transponder appeared briefly on panalyser.
	-153	021900	
		022011	Receiver out of lock.
		022620	Servo at prelimit.
		022650	Track terminated.

Table A-5. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Oct. 18/2231 to 19/0421

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		220000	Pedestal level complete.
		221100	Boresight No. 2 complete.
		222000	Receiver/telemetry calibrations complete.
		222300	Servo snap-ons complete.
		222600	Antenna sweeping on predicts.
		222700	Tele. recorders on.
		2230	Spacecraft at 0 degree elevation.*
↑		223100	Receiver in lock. One-way.
		223310	Servo to auto.
	-140	223320	Good data. Signal level is low due to ground
			reflections.
		223730	All tele. channels in lock except for channels
			5 and 6 which are below threshold. Channel 2
			is 50 percent in lock.
		224601	Receiver out of lock.
		224615	Receiver in lock.
		224835	Receiver out of lock.
		224958	Receiver in lock. Frequency changes each
			time receiver reacquires.
		224930	Servo to auto.
2231 to 0421,	-140	224950	Good data. All loops in lock.
GM-3		225200	Telemetry channels 5 and 6 out of lock.
			Channel 2 is 50 percent in lock.
	-138	230000	1-db variation.
	-137	231600	Signal level steady.
		232000	Tele. channels 5 and 6 out, channel 2, 50
			percent.
		232848	Receiver out of lock.
		232850	Servo to manual.
		232900	Receiver in lock.
		232907	Servo to auto.
		232924	Receiver out of lock.
↓		233000	Receiver in lock.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Oct. 18/2231 to 19/0421

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
2231 to 0421, GM-3		233007	Servo to auto.
	-137.5	233200	Servo bandwidth 0.25 cps, Receiver bandwidth
			20 cps.
		234500	Permission granted to change frequency of
			overseas phone call.
	-136.8	235140	
	-137.8	001000	
	-138.2	003000	
		003500	Tele. channels 5 and 6 out of lock, channel 2
			50 percent.
	-138.9	005000	
	-139.8	011000	
		011500	Data has been on 1 min. sample rate/60 sec.
			continuous doppler count since start of track.
		011722	Data changed to 2 sec. sample rate/1 sec.
			destructive doppler.
		011800	B-20 blip. Replaced faulty binary counter
			board.
		012950	Receiver out of lock.
		013030	Receiver in lock.
		013140	Receiver out of lock.
		013200	Receiver in lock.
		013240	Receiver switching to 60-cps bandwidth.
	-141	013300	
		013345	Servo to auto.
		013701	Data changed to 1 min. sample rate/60 sec.
			continuous doppler count.
		014300	Receiver out of lock.
		014500	Receiver in lock. Frequency changing.
		014540	Receiver out of lock.
	-147	014615	Receiver in lock.
		014745	Receiver out of lock. 020014Z data changed
			to 2-second sample rate.

Table A-5. (Cont'd)

STATION: DSIF-1

VIEW PERIOD: Oct. 18/2231 to 19/0421

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
2231 to 0421, GM-3		021300	Receiver in lock.
		021440	Receiver out of lock.
		021645	Receiver in lock.
		021658	Receiver out of lock.
	-152	021722	Receiver in lock.
		022055	Receiver out of lock.
	-147	022640	Receiver in lock.
		022838	Receiver out of lock.
	-150	024053	Receiver in lock.
		024130	Receiver out of lock.
	-152	024330	Receiver in lock.
		024450	Receiver switch to one-way.
		024800	Receiver out of lock.
		025001	Data switched to 1 min. sample rate/60 sec.
			continuous doppler count.
	-154	030215	Receiver in lock.
	-153	030250	
		030558	Receiver out of lock.
	-148	030608	Receiver in lock. 4-db variation.
		031300	Signal level varies between -148 dbm and
			-146 dbm.
		031515	Receiver out of lock.
		031550	Midwestern recorder off for paper change.
		032049	Midwestern recorder on.
	-154	040710	Receiver in lock.
		049902	Receiver out of lock.
	-154	041837	Receiver in lock.
		042115	Receiver out of lock.
		075200	Instructed to stop search.
		075400	Tele. recorders off.
		080000	Post cals. started.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 18/2258 to 19/0959

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		2249	Sent pretracking report.
		2250	Tape recorders on.
2258 to 2329, GM-3	-132	225805	Receiver in lock on the transponder signal.
		225809	Servo in auto.
		225930	Servo to 0.025 bandwidth.
		2301	Sent acquisition report.
		2305*	Spacecraft above horizon.
		231940	Telemetry punch started.
		232757	Transmitter on.
		232850	Receiver out of lock.
		232907	Receiver in lock two-way.
		232910	Servo auto.
		232944	Receiver in lock.
		233001	Receiver out of lock.
		233010	Receiver in lock one-way.
2331 to 0144, GM-1		233035	Receiver in lock two-way. Servo in auto.
		234600	Initiated command RTC-0.
		234641	Command verified.
		234820	Initiated command RTC-0.
		234840	Command verified.
		235000	Initiated command SC-1.
		235041	Command verified.
		235200	Initiated command SC-2.
		235240	Command verified.
		235400	Initiated command SC-3.
		235440	Command verified.
		235047	Channel B-2 event blip.
		240000	Initiate command RTC-2.
		000041	Command verified.
		002000	Initiate command RTC-2.
		002040	Command verified.
		004800	RTC-0 message transmitted.
		004841	RTC-0 verified.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 18/2258 to 19/0959

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		005000	RTC-0 message initiated.
		005041	RTC-0 verified.
		010300	Command SC-1 initiated. Verified 010341.
		010348	Channel B-2 blip.
		010500	Command SC-2 initiated. Verified 010541.
	-122	010525	Signal level falling.
		010700	Command SC-3 initiated. Verified 010741.
		011100	Command RTC-0 initiated. Verified at
			011141Z.
		011200	Command RTC-0 initiated. Verified at
			011241Z.
2331 to 0144,	-120	011600	Command SC-1 initiated. Verified at 011641Z.
GM-1		011645	Channel B-2-1 blip.
		011700	Command SC-2 initiated. Verified at 011741Z.
		011800	Command SC-3 initiated. Verified at 011841Z.
		012900	Command RTC-4 initiated. Verified 012941Z.
		012949	Receiver out of lock.
		013010	Receiver in lock one-way.
		013022	Channel B2 blip.
		013034	Receiver out of lock.
		013048	Receiver in lock. Servo in auto.
		013230	Two-way verified.
		013700	Hum on received signal. Fading. Gone
			at 0138Z.
		014351	Receiver out of lock.
		014400	Receiver in lock.
		014435	Receiver out of lock.
		014450	Receiver in lock.
0144 to 0235,		014651	Receiver out of lock.
GM-3		014717	Receiver in lock.
		014724	Servo in auto.
		014800	Receiver out of lock.
		014816	Receiver in lock. Servo in auto. Good data.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 18/2258 to 19/0959

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
0144 to 0235, GM-3		014830	Receiver out of lock.
		014931	Signal lost.
	-143	020808	Receiver in lock.
		021435	Signal fading. Receiver has lost lock three
			times.
		022720	In lock.
		023445	Out of lock. Several out-of-lock periods
			occurred but receiver generally in lock.
0237 to 0400, GM-7	-142	023640	In lock. Capsule signal.
		0253	Faulty flip flop in binary data address logic.
			Replaced and okay.
	-142	0254	
	-148	0310	
		0325	Data punch faulty, discovered at 0325Z as
			there is no machine to monitor outgoing data.
	-148	0332	
		0345	Transponder signal showing on "scope,"
			dropping to zero at 0346Z.
		034713	Receiver out of lock.
		035230	Receiver in and out of lock momentarily.
		035300	Receiver in lock.
		035400	Receiver out of lock.
		0350	Stopped oscillograph recorder for paper change.
		0354	Started oscillograph recorder.
		035510	In lock.
	-143	0356	
		040000	Receiver out of lock.
0401 to 0422, GM-3		040045	Receiver locked up on transponder signal.
		040256	All channels in lock except channel 8.
	-138	040446	
		040550	Receiver out of lock.
		040630	Receiver in lock. Servo in auto.
	-129	040800	

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 18/2258 to 19/0959

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
0401 to 0422, GM-3		040923	Transmitter on.
		0410	Started transmitting telemetry data.
		041120	Out of lock.
		041125	In lock.
		041439	Out of lock momentarily. In lock one-way.
		042049	Attempting to obtain two-way lock.
		042214	Receiver out of lock. Signal lost.
		0424	Transmitter off - tripped out. Reason
			unknown.
		04300	Started search for beacon signal.
0435 to 0445, GM-7	-147	043500	Receiver in lock. One-way. Beacon.
	-144	0444	
		0445	Receiver out of lock. Changing to transponder
			search.
0457 to 0959, GM-3 (intermittently)		045640	Receiver in lock. Servo in auto. One-way.
		045745	Transmitter on. Trying for two-way.
		045918	Receiver out of lock. Transmitter off.
	-132	051005	Receiver in lock. Servo in auto.
		051100	Out of lock. Servo in aided track.
	-129.5	051450	Receiver in lock. Servo in auto. Good data.
	-127	0518	
		052138	Receiver out of lock. Signal from
			transponder faded.
	-138	054550	Receiver in lock. Servo in auto.
		0547	Discriminators in lock. Started punching
			telemetry data.
	-147	054810	
		054814	Receiver out of lock.
		055812	Receiver in lock.
		055853	Receiver out of lock.
		060307	Receiver in lock. Servo in auto.
	-134	0604	
		060630	B 19 Channel: no more sync pulses observed.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 18/2258 to 19/0959

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
	-145	0607	
	-129.5	062210	Receiver out of lock. Three approximately
			30-second out-of-lock periods have occurred.
		062236	Receiver in lock. Servo in auto.
		062530	Receiver out of lock.
		065700	Receiver in lock. Servo in auto.
	-130.0	0658	Punching program A using local 400 c/s for
			channel 1.
		065830	Receiver out of lock.
		0711	Telemetry input signal was found to be
			attenuated too much giving 0.4 volts instead of
			1.5 volts rms.
	-132	071400	Receiver in lock. Servo in auto.
	-144	071520	Receiver out of lock.
0457 to 0959,		072210	Receiver in lock.
GM-3		073720	Receiver in lock. Servo in auto. Two out-of-
(intermittently)			lock periods of approximately 40-second
			duration have occurred.
	-133	080800	Receiver in lock. Servo auto.
	-138	0823	Hour angle low-speed tachometer not
			indicating.
		083330	Out of lock. Several in-lock periods obtained
			but receiver generally out of lock.
	-140	090310	In lock. Servo auto.
		093733	Out of lock. Several in-lock periods obtained
			but receiver generally out of lock.
		094330	Receiver in lock momentarily.
		0946	Hour angle tachometer okay.
	-130	094630	Receiver in lock. Servo auto.
		095030	Receiver out of lock.
		0959	Loss of signal, spacecraft below horizon.
		100456	Stopped all recorders.
			End of track.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 19/0836 to 19/1440

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0330	Countdown and initial equipment checks
			started.
		0540	Rec. initial checks completed. (Data cond.
			checks completed.)
		054030	Boresights completed by servo and data.
		054100	Antenna mode switch checks completed with
			instrumentation.
		0614	AGC and spin modulation checks completed by
			receiver and instrumentation.
		0640	Telemetry checks completed. Data checks
			completed.
		0815	Instrumentation and data on.
		0817	Receiver searching for capsule,
		082740	Servo in slave.
↑	-156	083550	Receiver in RF lock on the capsule signal.
		083925	Receiver switched to 300-second AGC time
			constant.
		083930	Good-bad data switch good.
		083950	Servo in aided track - bad command from
			computer.
0836 to 1440,		084000	Receiver out of lock. Spacecraft above local
GM-7			land mask.*
		084125	Receiver in lock.
		084224	Receiver switched to 300-second time constant
		084258	Good-bad data switch good.
	-149	084400	
		084530	Servo back in slave.
		085530	Servo in aided track.
↓		085600	Servo in slave.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 19/0835 to 19/1440

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
0836 to 1440, GM-7	-148	085750	
	-150	085830	
	-146	091000	
		092139	Receiver was on sideband previously and
			locked on capsule carrier at this time.
	-145.5	092230	
	-147.5	093105	
	-150.0	093645	
	-144	094420	
	-151	095800	
	-155	100530	
	-160	100750	
	-145	100935	
	-149	101930	
	-149	103230	
	-151	104350	
	-157	104940	
	-147	105110	
	-151	110600	
	-143	111300	
	-143	111700	
	-149	112300	
	-144	113700	
	-147	115500	
	-154	115900	
	-156	120200	
	-152	120500	
	-144	120800	
	-148	121400	
	-156	121700	
	-161	121845	
	-156	122000	
	-158	122300	

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 19/0835 to 19/1440

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
0836 to 1440, GM-7	-153	123100	
	-155	123500	
	-144	123700	
	-148	123900	
	-142	124100	
	-145	124700	
	-150	130200	
	-152	131000	
	-155	131600	
	-153	132200	
	-156	133200	
	-155	133800	
	-154	134200	
	-158	135000	
		135445	Servo in aided track (bad command).
	-154	135600	
	-160	140000	
		140045	Servo in slave.
	-155	140700	
	-151	142100	
	-155	142500	
	-157	143100	
	-155	143600	
	-156	144000	End of track.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 19/0846 to 19/1954

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0100	Countdown for the launch began at 1030Z Oct. 18
			and was completed before launch. Equipment
			now warming up.
		0830*	Spacecraft above antenna limits.
		083440	Telemetry on the recording.
		083450	Receiver trying to acquire transponder.
		083920	Servo in aided track mode due to bad commands
			from the computer.
		084507	Servo in slave mode.
		084602	Data started.
0846 to 0850 GM-7		084600	Receiver in lock on signal - not sure if signal is
			capsule or transponder.
		084832	Receiver in locked on capsule.
		085012	Receiver going out of capsule lock to try and
			acquire transponder.
0908 to 1525, GM-3 (intermittently)		090822	Receiver in lock with transponder.
		090857	Receiver out of lock.
		091610	Receiver in lock - signal strength manual
			-149.5 normal -135.5 dbm.
		091735	Receiver out of lock.
		091907	Receiver in lock. -145-dbm signal level.
			Received frequencies fluctuating.
		092011	Receiver out of lock.
	-134.5	092337	Receiver in lock.
	-128	093645	Receiver going in and out of lock.
	-126	094629	Rate 1 and 2 in sync.
	-127	094740	Receiver out of lock from 093759 to 094329 and
			094352 to 094540.
	-128.5	094830	
	-132.5	094950	
	-135	095022	Signal getting very erratic.
	-150	095055	
		095147	Receiver out of lock.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 19/0846 to 19/1954

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
↑	-141	095236	Receiver in lock.
	-130	095342	
	-129	095611	
		095630	Receiver out of lock.
		095858	Receiver in lock. Telemetry coming in and out.
	-137	095920	Telemetry coming in.
	-130	100015	
		100042	Spacecraft decommutator not stepping.
	-139	100737	
		101027	Receiver in lock. Spacecraft decommutator
			appears to be working. Receiver out of lock
			twice for 6 minutes and 3 minutes.
	-132.5	101048	
		101149	Receiver out of lock.
		102340	Receiver in lock. Signal is weak.
0908 to 1525,		102418	Receiver out of lock.
GM-3	-126.5	102943	Receiver in lock. Commutator is running.
(intermittently)	-128.5	103109	Spacecraft decommutator just stopped stepping.
	-126.5	103215	960.036852 receiver freq.
		103316	Telemetry out.
	-134.5	103419	960.036542 receiver freq.
	-138.5	103506	
	-137	103843	
		104304	Receiver in lock. Spacecraft decommutator
			started then stopped. Receiver has been in and
			out of lock twice for three and four minutes.
		110630	Receiver frequency dropping.
		110827	Rate one and two in sync.
		111450	Telemetry lost syncs.
		111850	Receiver out of lock. Receiver still going in
			and out of lock.
	-149	120500	Receiver in lock.
↓	-132.5	120804	

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 19/0846 to 19/1954

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
0908 to 1525, GM-3 (intermittently)	-130.5	120842	
		121200	Receiver frequency fluctuating.
		121336	Receiver out of lock.
	-149	122222	Receiver in lock.
		122320	Receiver out of lock.
	-145	122557	Receiver in lock.
		122630	Receiver out of lock.
	-130	122815	Receiver in lock.
		122900	Commutator is running.
	-140	122925	Commutator stopped running.
	-139	123417	
		123450	Receiver out of lock.
	-138	123908	Receiver in lock.
		123904	Receiver out of lock.
	-130	124312	Receiver in lock. Commutator is running.
		124404	Commutator stopped.
	-138	125347	Receiver back in lock after 20 seconds out of
			lock. Commutator still not operating.
	-140.5	130300	
	-142.5	130800	
		135435	Servo in aided track. Computer lost program.
		140030	Servo back in slave.
		152500	Echo antenna to aided track. Following
			trajectory.
1532 to 1705, GM-7	-148	153200	Receiver in lock with capsule. Frequency of
			capsule is 960.15 Mc.
	-150	160000	
		162000	Bandwidth of RF tracking filter is 20 cycles.
			This was changed prior to acquisition of
			capsule.
		164520	Receiver out of lock. Tried to increase gain
			of signal by searching with antenna - no help.
	-148.5	164630	Receiver in lock.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 19/0846 to 19/1954

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1532 to 1705, GM-7	-151	165800	Receiver in lock after going out of lock at
			165500.
		170500	Receiver out of lock with capsule in order to
			try to lock up with the transponder again. RF
			tracking filter bandwidth switched to 60 cycles.
1718 to 1854, GM-1 and GM-3 (intermittently)	-141	171740	Receiver in lock with the transponder. Freq.
			is 31001136 Mc.
		171815	Transmitter on and sweeping in frequency to
			acquire two-way lock.
		171900	Receiver out of lock.
		172000	Transmitter off.
	-151	172145	Receiver in lock and transmitter on and
			sweeping.
		172235	Receiver out of lock.
		172400	Receiver in lock.
		172435	Receiver out of lock.
	-136	172615	Receiver in lock. Transmitter is sweeping.
			Attempting to acquire two-way lock.
		172725	Receiver out of lock.
	-133	172757	Receiver in lock.
		172910	Apparent two-way lock. Data switch to good.
		173210	Commutator is stepping.
	-139	173240	Commutator stopped.
		173315	Receiver out of lock.
		173610	Data switch to bad.
	-147.5	173808	Receiver in lock. Transmitter is sweeping
			band for two-way lock.
		173925	Data switch to good.
		173958	Apparent two-way lock.
		174030	Receiver out of lock. Data switch to bad.
	-149	174722	Receiver in lock.
		174800	Commutator is stepping.
		175005	Receiver out of lock. Commutator stopped.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 19/0846 to 19/1954

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1718 to 1854, GM-1 and GM-3 (intermittently)	-140	175538	Receiver in lock. Data switch to good.
			Transmitter is searching.
	-136	175631	
	-130.5	175722	
	-142	180040	
		180100	Receiver out of lock. Data switch to bad.
		180615	Receiver in lock. Data switch to good.
		180730	Receiver out of lock.
	-137	180812	Receiver in lock and data switch to good.
		180835	Receiver out of lock. Data switch to bad.
		181553	Receiver in lock. Data switch to good.
	-149	181614	Transmitter is searching.
		181822	Receiver out of lock. Data switch to bad.
	-140	182340	Receiver in lock. Data switch to good.
			Transmitter is searching.
	-131	182532	
	-139	182843	
		182910	Receiver dropped lock. Data switch to bad.
	-140	183343	Receiver in lock. Data switch to good.
			Transmitter is sweeping.
	-153	183442	
		183650	Receiver out of lock.
	-140	184359	Receiver in lock. Data switch to good.
			Transmitter is sweeping.
		184900	Servo is checking trajectory data by peaking
			signal strength. Receiver out of lock 184643
			to 184840.
		185430	Receiver out of lock.
1856 to 1908, GM-7	-151	185630	Receiver in lock on capsule beacon. Freq. is
			960.024 Mc. Data switch to good.
		190520	Receiver out of lock.
	-149	190617	Receiver in lock on capsule beacon.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 19/0846 to 19/1954

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1856 to 1908 GM-7		190820	Receiver out of lock to try to acquire space-
			craft transponder. Data switch to bad.
1913 to 1954 GM-3 (intermittently)		191248	Receiver in lock. Data switch to good. Freq.
			is 960.033 Mc.
		191310	Transmitter on and sweeping in frequency.
	-151	191358	
	-155	191442	
		191500	Receiver out of lock. Data switch to bad.
	-144	192134	Receiver in lock. Data switch to good.
			Transmitter searching.
		194308	Receiver out of lock. Data switch to bad.
			Receiver has been in lock a total of approx.
			4-1/4 minutes since 192134.
		194400	Transmitter off.
	-140	194840	Receiver in lock. Data switch to good.
	-132.5	195105	
		195148	Transmitter on and searching.
	-155	195300	
		195350	Receiver out of lock. Data switch to bad.
		201540	Transmitter off.
		201600	Telemetry stopped all recording.
		201700	End of track.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 19/1652Z to 20/0155

Servo Bandwidth 0.05 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		1632*	Spacecraft above local land mask.
		1635	At acquisition point searching for transponder.
			No success.
		1650	Capsule search.
1652 to 1655 GM-7	-148.5	165147	Capsule lock 2 minutes.
	-158.5	165500	Capsule lock for 10 seconds.
		165510	Transponder search.
↑		1718	Transponder lock for 30 seconds.
	-154	172145	Momentary transponder lock.
1718 to 1749 GM-3	-144	1726	Transponder intermittent lock for 1 minute.
		1730	Transponder momentary lock.
(intermittently)	-131.5	1738	Transponder lock for 2 minutes.
		1747	Transponder lock for 2 minutes.
↓		1800	Transmitter on briefly. No success.
			Capsule search.
↑	-150	1802	Capsule lock for 7 minutes.
		1808	Transponder visible on panaylser.
1802 to 1816, GM-7		1810	Capsule lock for 6 minutes.
		1815	Good data sample.
↓		1816	Good data sample.
		181603	Transponder search.
		181742	Transmitter on for 3 minutes - no success.
↑		1824	Intermittent transponder lock for 6 minutes.
	-130	1829	Transponder lock for 2 minutes.
1824 to 1913, GM-3	-137.5	1834	Transponder lock for 2 minutes.
		1844	Transponder lock for 3 minutes.
		1851	Transponder lock for 5 minutes.
		1902	Momentary transponder lock.
↓	-135	1913	Transponder lock for 3 minutes.
		1915	Capsule search.
1917 to 1931, GM-7	-154	1917	Capsule lock for 9 minutes.
		1925	Good data sample.
↓		1926	Good data sample.

*Time estimated from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 19/1652Z to 20/0155

Servo Bandwidth 0.05 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1917 to 1931, GM-7		1928	Capsule lock for 3 minutes
	-154.5	1928	Three good data samples
1931 to 2029, GM-3	-150	1931	Transponder search. Momentary transponder
			lock.
		1933	Momentary transponder lock.
	-136	1943	Transponder lock for 90 seconds.
	-148	1948	Transponder lock for 2 minutes
		1951	Transponder lock for 3 minutes
		1953	Good data sample
		2019	Transponder lock for 50 seconds.
	-157	2029	Momentary transponder lock.
		2030	Capsule search.
(A)	-156	2033	Capsule lock for 12 minutes with one drop out.
		2045	Transponder search for 1 hour. No success.
		2145	Capsule search.
2147 to 2203, GM-7		2147	Capsule lock for 9 minutes
	-159	2148	
	-154.5	2149	
		2158	Capsule lock for 5 minutes
		2200	Three good data samples
		2203	Transponder search for 1 hour. No success.
2304 to 2321, GM-7	-158.5	2304	Capsule lock for 6 minutes
		2313	Capsule lock for 8 minutes
	-156	2315	
		2325	Transponder search for 1 hour. No success.
		0025	Capsule search
0030 to 0045, GM-7		0030	Capsule lock for 6 minutes.
	-156	0032	
		0035	Good data sample
		0038	Capsule lock for 8 minutes.
		0039	Seven good data samples
		0045	Transponder search for 1 hour. No success.

(A) - 2033 to 2045, GM-7

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 19/1652Z to 20/0155

Servo Bandwidth 0.05 cps

Receiver Bandwidth 60 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
↑	-160	0145	Capsule search. Capsule lock for 14 minutes
0145 to 0159,			with one drop out.
GM-7		0148	Two good data samples.
↓		0155	Four good data samples.
		0200	Begin transponder search for 30 minutes.
		0230	Track terminated. Search unsuccessful.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 20/0032 to 20/1000

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		2200	Short countdown commencing.
		2230	Receiver pre-checks completed.
		2230	Instrumentation checks completed.
		2230	Servo and hydraulic checks completed.
		2230	Data checks completed.
		2230	Data condition checks completed.
		2245	Closed loop calibrations completed.
		0000	Recorders on.
		0001	No drive in declination high speed.
		0005*	Spacecraft above land mask.
		0007	Jammed by-pass valve on Dec HS repaired.
		0009	Antenna at acquisition point.
		0010	Searching for transponder.
		0016	Changed to beacon frequency.
↑		003210	Receiver in lock servo auto.
0032 to 0043		003310	Receiver out of lock
GM-7	-148	003740	Receiver in lock servo auto.
↓		004239	Receiver out of lock.
		0044	Starting search for transponder
		0100	Searching for beacon. Transponder search
			unsuccessful.
↑		010040	Receiver in lock.
		010050	Servo in auto.
	-150.1	0101	
		010150	Receiver out of lock.
0100 to 0115		010520	Receiver in lock. Servo auto.
GM-7	-149	0107	
	-148	0109	
		0111	Receiver out of lock. Servo aided.
		011330	Momentarily in lock
↓		011407	Receiver in lock. Servo in auto.
		0115	Searching for transponder.
		0215	Stop transponder search

*Approximate time from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 20/0032 to 20/1000

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
↑		022120	Receiver in lock. Good data. Servo auto.
			(Beacon)
0221 to 0230,		022250	Out of lock.
GM-7	-150	022400	In lock.
		022610	Out of lock.
		022940	In lock. Servo auto.
↓		023020	Out of lock. Begin searching for transponder.
		0330	Stop transponder search.
↑		033130	Receiver in lock (beacon), servo in auto.
		033200	Out of lock.
0331 to 0345,		033220	In lock.
GM-7	-150	0338	
	-155	0341	
	-155	0344	
↓		034510	Receiver out of lock. Servo aided
		0346	Searching for transponder
↑		044730	Locked up on beacon. Transponder search
			unsuccessful
		044740	Out of lock.
		044810	Receiver in lock, good data.
0447 to 0458,		044910	Out of lock.
GM-7		045020	In lock.
		045040	Out of lock
	-148.7	045220	In lock, servo in auto.
	-152.5	0455	
↓		045830	Out of lock.
		0500	Searching for transponder.
		0600	Begin search for beacon. Transponder search
			unsuccessful..
		061100	Receiver in lock momentarily
		0615	Switched to transponder search.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 20/0032 to 20/1000

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
↑		0715	Searching for beacon. Transponder search
0715 to 0730			unsuccessful.
GM-7		072945	Receiver in and out of lock for 8 seconds at
(intermittently)			072849Z and 072917Z. Receiver has been con-
↓			tinually in and out of lock.
↑		0730	Searching for transponder.
		0830	Started beacon search. Transponder search
			unsuccessful.
		083020	Receiver in lock. Servo in auto. Good data.
0830 to 0845,		083159	Out of lock.
GM-7	-151.5	083201	Receiver in lock. Servo in auto. Good data.
(intermittently)	155	083238	Falling.
		083313	Out of lock.
		083835	Receiver continues in-and-out-of-lock
			condition.
↓	-148.5	084410	
		084517	Searching for transponder.
		0924	Hum on all channels.
		0925	Started Tape Recorder 'A', hum still present.
		904030	Stopped looking for transponder. Trying to
			track beacon (capsule).
(A)		094650	In- and out-of-lock conditions continue.
		100000	Receiver out of lock. End of track.

(A) - 0947 to 1000, GM-7 (intermittently)

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 20/1020 to 20/2028

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0630	Countdown begun - equipment warming up.
		070000	Servo boresight checks completed.
		0839	Countdown completed.
		0845	Telemetry recorders on.
		0850*	Spacecraft above antenna limits.
		085100	Servo in slave mode.
		085123	Receiver is searching.
		094521	Receiver is still searching with no success.
		095223	Servo going off tape to try and aid in search.
			for capsule.
		0958	Telemetry replaced defective DC amplifier in
			spin modulation channel.
		101015	Servo going ahead 10 minutes - was ahead of
			prediction 10 minutes prior - will stay in this
			position for 20 minutes
↑		101958	Receiver in lock - signal is weak.
		102054	Receiver out of lock with capsule.
		102058	Servo in slave mode.
1020 to 1033,	-150	102348	Receiver in lock.
GM-7	-144.5	102503	Signal level is erratic.
(intermittently)	-148	102553	
↓		102854	Receiver out of lock.
		103221	Receiver in lock.
		103244	Receiver out of lock.
		103351	Receiver trying to acquire the transponder.
		1139	Receiver could not acquire transponder.
↑		114052	Receiver in lock for 3 seconds with capsule.
	-146.5	114126	Receiver in lock with capsule.
1156 to 1141,	-152	114225	
GM-7		114232	Receiver out of lock.
(intermittently)	-149.5	114328	Receiver in lock.
↓		114500	Receiver reports a 300-second AGC time con-
			stant and a 20-cycle bandpass filter setting.

*Approximate time from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 20/1030 to 20/2028

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
↑		114746	Receiver in lock at threshold.
1156 to 1141,	-149.5	115126	Receiver out of lock from 114823 to 115009.
GM-7	-147	115245	
(intermittently)	-150	115538	
↓		115549	Receiver out of lock.
		115619	Receiver is now trying to acquire the
			transponder.
↑	-149.5	125725	Capsule acquired. Transponder not acquired.
	-145	130000	
	-145	130041	
	-149	130202	
1257 to 1310,		130224	Out of lock.
GM-7		130436	Receiver in lock.
	-145	130623	
	-144	130755	
	-145	130800	Capsule sub-freq. 556 c/s.
↓		131015	Receiver out of lock.
		131033	Receiver is now trying to acquire transponder.
		141130	Receiver unable to acquire the transponder.
(A)		141210	Receiver now trying to acquire the capsule.
↑		142139	Receiver in lock.
	-145.5	142310	
1412 to 1428,		142422	Receiver out of lock.
GM-7		142450	Receiver in lock.
	-152	142702	
↓		142821	Receiver out of lock.
		143055	Receiver is now searching for the transponder.
		153000	Receiver is now searching for the capsule.
↑		153134	Receiver in lock.
		153400	Receiver out of lock to look for carrier.
1531 to 1552,		153650	Receiver in lock.
GM-7		153948	Receiver out of lock.
↓	-146	154000	Receiver in lock.

(A) - 1412 to 1428, GM-7

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 20/1020 to 20/2028

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		154214	Receiver out of lock
	-152	154650	Receiver in lock.
1531 to 1552,	-147	154802	
GM-7	-146	154826	
		154846	Checking servo positions with receiver.
		155220	Receiver out of lock. Looking for transponder.
		155222	Servo optimized position. Not off much.
		160145	Antenna on aided track.
		164545	Receiver started searching for capsule beacon.
		164646	Receiver in lock. On the capsule beacon.
	-146	164727	
		164920	Receiver out of lock.
1647 to 2028		165309	Receiver in lock on capsule beacon.
GM-7	-146.5	165710	
(intermittently)	-148	202402	Receiver in lock. Receiver has been in and out
			of lock since 165933. Receiver generally out
			of lock 1 to 3 minutes and in lock 1 to 6
			minutes.
		202749	Receiver out of lock.
		202800	Antenna in prelimit.
		202830	All telemetry recorders stopped.
		202900	End of track.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 20/1708 to 21/0244

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1708 to 2046, GM-7 (intermittently)		1645*	Spacecraft above land mask.
		1700	At acquisition point searching for capsule.
		1708	Momentary capsule lock.
		1714	AGC time constant to 300 seconds.
	-156	1717	Capsule lock for 2 minutes.
		1721	Capsule lock for 7 minutes.
	-157.5	172351	First good data sample.
	-156	172530	Filters used in angle channel recording.
	-154	172730	
	-160.5	172930	Capsule lock lost.
		1730	Intermittent capsule lock for 150 seconds.
	-160.5	1740	Capsule lock for 8 minutes.
	-154	1743	
	-156	1746	
		1749	Capsule lock for 7 minutes.
	-159.5	1750	
	-155.5	175230	
	-153	1755	
		1757	Intermittent capsule lock for 3 minutes.
		1800	Capsule lock for 7 minutes.
	-157.5	1801	
	-152.5	1804	
		1808	Capsule lock for 8 minutes.
	-155	1811	
		1817	Capsule lock for 40 seconds.
	-159.5	181730	
	-159.5	1819	Capsule lock for 6 minutes.
	-157	182130	
		1826	Capsule lock for 2 minutes.
	-159.5	1830	Capsule lock for 4 minutes.
	-154	183210	
		183440	Intermittent capsule lock for 2 minutes.
		1838	Capsule lock for 90 seconds.

*Approximate time from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 20/1708 to 21/0244

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		184030	Capsule lock for 4 minutes.
	-154	184130	
		1846	Capsule lock for 8 minutes.
	-154	1849	
	-154	185230	
		1856	Capsule lock for 30 seconds.
	-158.5	185730	Capsule lock for 6 minutes.
	-153	1902	
		190430	Capsule lock for 90 seconds.
		1907	Capsule lock for 5 minutes.
	-153	191130	
	-160	1913	Capsule lock for 40 seconds.
		1915	Capsule lock for 7 minutes.
	-154	192030	
		192330	Momentary capsule lock.
1708 to 2046,	-156	1924	Capsule lock for 1 minute.
GM-7		192540	Capsule lock for 6 minutes.
(intermittently)	-154	1930	
		1932	Capsule lock for 40 seconds.
		1934	Capsule lock for 6 minutes.
	-157	1935	
		1942	Momentary capsule lock.
		1945	Capsule lock for 6 minutes.
	-152.5	194830	
		1953	Capsule lock for 7 minutes.
	-155	1957	
		200020	Intermittent capsule lock for 1 minute.
		2002	Capsule lock for 40 seconds.
		200330	Capsule lock for 6 minutes.
	-155.5	200530	
		201130	Capsule lock for 100 seconds.
		201340	Capsule lock for 5 minutes.
	-155.5	2015	

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 20/1708 to 21/0244

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1708 to 2046, GM-7 (intermittently)		2019	Momentary capsule lock.
		202030	Momentary capsule lock.
		2022	Capsule lock for 6 minutes.
	-155.5	2024	
		2031	Capsule lock for 3 minutes.
	-157	2032	
		2035	Capsule lock for 3 minutes.
		2039	Momentary capsule lock.
		2041	Capsule lock for 5 minutes.
	-156	2045	
		2046	Transponder search for 34 minutes. No
			success. (10-second AGC time constant used.)
			Tracking stopped at request of Net Control to
			allow replay of first pass TM data program A.
2236 to 2305 GM-7 (intermittently)		2236	Resumed capsule search to check predictions.
			Search continued for 30 minutes with usual
			periodic capsule lock.
		2305	Transponder search for 40 minutes - no
			success (10-second AGC time constant used).
		2345	Resumed capsule search.
2352 to 0244 GM-7 (intermittently)		2352	Capsule lock for 50 seconds.
		2354	Capsule lock for 4 minutes.
		000031	Capsule lock for 5 minutes.
		000334	Filters removed from angle channel record,
			for 6 minutes. Filter position used - 3.
	-157.5	000420	
		0006	Capsule lock for 40 seconds.
		0008	Capsule lock for 30 seconds.
		0009	Capsule lock for 50 seconds.
	-156	0011	Capsule lock for 2 minutes.
		0014	Capsule lock for 3 minutes.
		001720	Intermittent capsule lock for 40 seconds.
		001930	Capsule lock for 3 minutes.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 20/1708 to 21/0244

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
2352 to 0244, GM-7 (intermittently)		0023	Capsule lock for 150 seconds.
	-156.5	002420	
		0027	Momentary capsule lock.
		0028	Capsule lock for 40 seconds.
	-158	0030	Capsule lock for 2 minutes.
		0032.21	Capsule lock for 4 minutes.
	-155	003340	
		0039	Capsule lock for 6 minutes.
	-155.5	0042	
	-155	004430	
		004630	Momentary capsule lock.
		004721	Capsule lock for 50 seconds.
		004841	Capsule lock for 2 minutes.
	-155.5	005030	
		0051	Capsule lock for 4 minutes.
	-155.5	0054	
		0057	Capsule lock for 90 seconds.
		0059	Capsule lock for 100 seconds.
	-159.5	0101	Momentary capsule lock.
		010111	Capsule lock for 2 minutes.
	-156	010250	
		0105	Capsule lock for 20 seconds.
		0106	Intermittent capsule lock for 40 seconds.
		0107	Capsule lock for 7 minutes.
	-153.5	011240	
		0116	Capsule lock for 7 minutes.
	-156	011950	
		0124	Momentary capsule lock.
		0125	Momentary capsule lock.
		0127	Capsule lock for 2 minutes.
	-155.5	0128	
		0130	Capsule lock for 210 seconds.
	-156.5	013130	

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 20/1708 to 21/0244

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
2352 to 0244, GM-7 (intermittently)		013631	Capsule lock for 2 minutes.
		0138	30.556 Mc/s bias oscillator frequency, printed
			out on transmitter digital printer. 455 kc/s
			reference oscillator frequency printed out on
			receiver digital printer. Transmitted by tele-
			type at end of pass.
	-157	013931	Capsule lock for 2 minutes.
		0141	
		0142	Capsule lock for 30 seconds.
		0144	Momentary capsule lock.
	-157	015021	Capsule lock for 2 minutes.
		0154	Capsule lock for 2 minutes.
		015631	Capsule lock for 2 minutes.
		015841	Capsule lock for 3 minutes.
	-158.5	0201	
		0203	Capsule lock for 30 seconds.
		0204	Capsule lock for 2 minutes.
		0208	Capsule lock for 210 seconds.
	-156.5	0210	
		0214	Capsule lock for 2 minutes.
	-160.5	0215	
		022441	Capsule lock for 20 seconds.
		022521	Capsule lock for 5 minutes.
		0232	Capsule lock for 3 minutes.
		0237	Capsule lock for 2 minutes.
	-157	023830	
		0239	Momentary capsule lock.
		023951	Capsule lock for 30 seconds.
		024111	Capsule lock for 20 seconds.
	-161	0243	Capsule lock for 50 seconds.
		0244	Track terminated.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 21/0034 to 21/1000

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		1800	Countdown started.
		1900	T/M tape recorders checked out. Servo
			electronics and hydraulics checks completed.
		2205	Data checkout completed.
		2240	Receiver internal checks completed.
		2358	Tape recorders started.
		0000	Antenna at acquisition point.
		0010*	Spacecraft above land mask.
↑	-153	003429	Receiver in lock on capsule signal.
		003431	Receiver out of lock.
		004415	Out of lock. Predictions approx. 0.17 degree
			slow.
		005027	In lock. Preceded by several brief locks.
		005034	Out of lock.
			Signal level -151.0 to -155.0.
0034 to 0732,		0450	Received message to warm up transmitter for
GM-7			possible command transmission. Receiver
(intermittently)			intermittently in lock for brief periods.
		072845	Transmitter on. Receiver obtaining
			occasional brief locks.
		072850	Transmitter off. Tripped out.
		072920	Transmitter on (Transmitting).
		073010	Receiver in lock. Out 073158.
		073047	Initiated RTC-3 command.
↓		073129	Verified RTC-3.
		073200	Searching for transponder.
		073700	Searching for beacon.
↑		073912	In lock.
0739 to 0759		073920	Out of lock.
GM-7		075757	In lock.
↓		075820	RTC-3 initiated.
		075901	Verified VCO frequency 29.668000.
			Searching for transponder.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 21/0034 to 21/1000

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		075930	Changing VCO frequency.
GM-7	-151	081035	Receiver in lock on capsule signal.
		081110	Command RTC-3 initiated.
		081151	Verified.
			Searching for transponder.
GM-7	-157.0	083105	Receiver in lock on capsule signal.
		083120	Command RTC-3 initiated.
		083201	Verified. Searching for transponder.
		083720	Searching for beacon.
GM-7	-152.0	083830	Receiver in lock.
		083840	RTC-3 initiated.
		083921	Verified.
			Searching for transponder.
		084500	Searching for beacon. Transmitter off.
(A)	-155	084530	Receiver in lock. Servo auto.
		084646	Receiver out of lock.
0845 to 1000 GM-7 (intermittently)			In lock Out of lock
			084720 085100 -153 dbm
			085332 090010 -155 dbm
			0902050 090930 -153.5 dbm
	-153	0908	
		1000	Stopped recorder. Receiver continued inter-
			mittent lock conditions with signal levels of
			-154 dbm.
			End of track.

(A) - 0845 to 1000, GM-7 (intermittently).

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 21/0900 to 21/1812

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0630	Station preparation for track initiated.
		0655	Started installation of 3-1/8 inch RF line
			sections to convert transmitter to 10-kw
			configuration.
		0710	Transmitter digital printer hooked to monitor
			455-kc oscillator frequency. Receiver digital
			printer set up to monitor 30.5065 Mc bias
			oscillator frequency per directions from Net
			Control (see message 2100508).
		0812	Installation of 3-1/8 in. RF line sections
			completed.
		084400	Receiver counter switch produce transients
			which cause loss lock in doppler frequency
			shifter loop.
		085500	All instrumentation recorders on (except
			Sanborn).
		085740	Servo in slave to drive tape.
		085900	Data on.
0900 to 0934, GM-6		0900	Transmitter on full power. Spacecraft above
			antenna limits. *
		090114	RTC-3 initiated.
		092100	RTC-3 initiated. Nineteen RTC-3 commands
			have been sent at 1-kc increments.
		092800	Changing acquisition sweep driver batteries
			(receiver).
		0931	Completed command transmission in 1-kc
			steps.
		0933	RTC-3 initiated .5 kc below nominal in 1-kc
			steps.
		093348	Stopped sending commands. A total of 23
			commands have been sent.
		093559	Receiver completed battery change as logged
			092800.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 21/0900 to 21/1812

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0950	All stations go to 10-second non-destruct count
			as directed by JPL Test Director.
		0951	Data to 10-second sample rate.
		100506	Receiver has partial lock (threshold).
		100513	Lost partial lock.
1005 to 1136 GM-6		100522	Begin transmitting RTC-3 commands.
		101710	Transmitter off air (reason unknown).
		104117	RTC-3 number 37 initiated.
		111037	RTC-3 initiated - questionable.
		111600	Transmitter off momentarily. Still trans-
			mitting RTC-3 commands.
		111601	RTC-3 initiated - questionable.
		113526	Lost transmitter.
		113530	Transmitter on.
		113538	Conclude RTC-3 transmission. A total of 71
			commands initiated.
		1137	Switched to capsule frequency (searching).
1139 to 1322, GM-7 (intermittently)		113850	Receiver in lock. Signal level -157 to -149 dbm.
		114109	Receiver out of lock.
	-156	114500	Receiver in lock.
	-150.5	114730	
		1200	Both stations going on capsule signal. Trans-
			mitter secured. Receiver in-and-out-of-lock
			four times since 114803.
	-156	121600	Receiver in lock. Two previous 30-second
			locks.
	-152	1219	
		132216	Receiver out of lock switching to transponder
			frequency. Receiver has been in-and-out-of-
			lock since 121600. Out of lock periods gener-
			ally 1 or 5 minutes. In-lock periods generally
			from 1/2 to 2 minutes.

Table A-5. (Cont'd)

STATION: DSIF-3

VIEW PERIOD: Oct. 21/0900 to 21/1812

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		143849	Leading edge of the Moon passed the optical
			axis.
		150900	Receiver going to capsule beacon frequency.
GM-7		151020	Receiver in lock. On capsule beacon.
		151030	Receiver out of lock. Switching to transponder
			frequency.
		1637	Occultation begins. *
		164448	Receiver looking for spacecraft capsule
			beacon.
		171325	Servo out of slave and on aided track due
			to bad commands from computer.
		173138	Echo antenna back in slave.
		1744	Occultation ends*.
		174750	Receiver in lock on capsule beacon. Data
1748 to 1812 GM-7			switch to good.
		174840	Receiver out of lock. Data switch to bad.
(intermittently)	-157	175030	Receiver in lock on capsule. Data switch
			to good.
		180850	Signal level is at threshold. Receiver out of
			lock a total of 14 minutes since 175240.
		181152	Receiver out of lock.
		181400	Receiver will now switch to Mariner II.
		181415	All telemetry off.
		181427	Servo out of slave and to aided track.
		181430	End of track for Ranger 5. Switch to
			Mariner II.

*See Space Flight Operations Memorandum Ranger V, JPL Engineering Planning Document 133.

Table A-5. (Cont'd)

STATION: DSIF-2 **Servo Bandwidth** _____ cps

VIEW PERIOD: Oct. 21/0909 to 21/2045 **Receiver Bandwidth** _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0600	Initial equipment checks and calibration
			started.
		0650	Instrumentation initial checks completed.
		0700	Instrumentation completed checks with
			computer.
		0845	Receiver and instrumentation completed AGC
			checks.
		0855	Data and telemetry on.
		0900	Servo in aided. Spacecraft above antenna
			limits*.
		090047	Servo in slave.
0909 to 0934, GM-7		090840	Receiver in lock on the capsule signal.
		091134	Good bad data switch good.
		091300	Discriminator 2 in lock.
	-152	0914	
	-158	091520	
	-156	091800	
		092000	Receiver out of lock.
		092206	Receiver in lock.
	-156	092630	
		092940	Receiver out of lock.
		092952	Receiver in lock.
	-160	093020	
		093040	Receiver out of lock.
		093050	Receiver in lock.
	-154	093254	
		093350	Receiver out of lock - searching for
			transponder frequency.
		095055	Data going to10-second nondestruct count mode.
		101050	Receiver returning to capsule signal. Trans-
			ponder search unsuccessful.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 21/0909 to 21/2045

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1012 to 1139, GM-7 (intermittently)		101140	In lock.
		101725	Out of lock.
		101807	Receiver in lock.
	-152	102030	
		102615	Receiver out of lock.
		103000	Receiver in lock.
		112358	Receiver out of lock. Three out-of-lock
			periods (total of one minute) have occurred
			since 103000.
	-158	112400	Receiver in lock.
		113840	Receiver out of lock. Try to acquire trans-
			ponder signal.
		1202	Ampex "B" off. Not able to acquire trans-
			ponder going back to capsule signal.
1207 to 1638, GM-7	-155.5	120710	RF lock on capsule signal.
		125430	Receiver AGC time constant to 300 seconds.
		1358	Servo optimizing offsets AGC TC 10 seconds.
	-157	1410	AGC TC back to 300 seconds.
	-168	1415	Threshold.
	-159.6	1418	
		141950	Momentarily out of lock.
	-168	142430	Momentarily out of lock.
	-168	142525	
		142530	Out of lock.
		142555	In lock.
		143509	Threshold, momentarily out of lock.
		143956	Trailing edge of Moon in center of TV screen
			HA 357.830, Dec 017.478.
		144230	Out of lock.
		144300	In lock.
		144530	Threshold.
	-154.55	144740	
	-158.5	144800	

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 21/0909 to 21/2045

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1207 to 1638, GM-7		144900	Trailing edge of Moon at RF boresight position
			HA 000.150, Dec 017.494.
	-157.1	145040	
		145912	Data is sampling at once per second and
			transmitting at once per second also.
			Data is sampling at once per second and
			transmitting at once per 10 seconds rate.
		151150.	Out of lock.
		151345	In lock.
	-155.8	151645	
		1526	Sending tracking data once per 10 seconds in
			real time - storing all previous.
		153000	Out of lock.
		153030	In lock.
		153230	Out of lock momentarily.
	-154.2	153350	
		153437	10-sec AGC time constant.
		154030	Threshold going out of lock.
		154700	In lock.
		01600	Out of lock.
		160135	In lock.
		1608	Out of lock.
		1610	In lock.
	-155.2	1612	
	-157.1	161328	
		161350	Momentarily out of lock.
		163250	Momentarily out of lock 31.000821 VCO ref.
	-155.2	163450	
		1637	Occultation begins.*
		163819	Out of lock.
		1647	Resetting maser still searching for capsule.
		1649	Teletype transmitter failure.
		1650	Maser peaked - less than 15 db low.

*See Space Flight Operations Memorandum Ranger 5, JPL Engineering Planning Document 133.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 21/0909 to 21/2045

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		1710	The data high-speed punch being used for
			sending tracking data is still bad, being
			replaced with spare.
		171330	Bad commands from computer, in aided.
		172930	In slave.
		172200	Transmitting tracking data at once/10 seconds.
			Sampling at once/second.
		1744	Occultation ends. *
1745 to 2045, GM-7 (intermittently)		174502	In lock on capsule signal.
	-157.5	175200	10-second AGC time constant. Servo optimizing
			offsets.
		175700	300-second AGC time constant.
		1758	Momentarily out of lock.
		1800	10-second AGC time constant. Servo checking
			optimization. No offset changes.
		1803	Momentarily out of lock.
		1804	Momentarily out of lock.
	-154.5	1809	
		1821	Momentarily out of lock.
		1823	Momentarily out of lock.
	-158.4	1855	
	-162.9	1903	
	-159.5	1936	
	-162.9	2003	
	-162	2006	
	-161.8	2020	
	-160.7	202236	
	-164.5	202832	
	-165	2038	
		204500	End track. Data and instrumentation off.
			Several out-of-lock and bad data periods
			occurred after 1855 but the receiver was
			generally in lock with good data.

*See Space Flight Operations Memorandum Ranger 5, JPL Engineering Document 133.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 21/1825 to 22/0240

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		1646	Antenna at acquisition point, receiver
			scanning, recorders on and data sampling.
			One-second sample rate with secondary punch
			at 10 seconds. the latter being transmitted in
			near-real time.
		1653	Antenna positioned ahead of predictions just
			above horizon mask (HA 284.8 Dec 18.0).
			Spacecraft above land mask.*
		1700	Secondary punch punching at erratic intervals,
			typically 9 seconds instead of 10 seconds.
			Checks revealed no data corruptions.
		1701	Antenna following predictions. Moon not
			visible due to complete cloud cover.
		1708	Doppler mixer output predictions received
			for period starting 1730.
		1719	Secondary punch now punching at correct 10-
			second intervals. Faulty card replaced.
		1744	Occultation ends.**
		1745	At request of Net Control, antenna positioned
			towards lighted edge of Moon as judged from
			predictions.
		1802	Notification received that Goldstone tracking
			at signal level of -157.5 dbm.
		1814	Commenced 1-degree spiral scan along
			predictions.
		1819	Returned to predictions and then commenced
			2-degree spiral scan along predictions.
		1822	Returned to predictions on receipt of infor-
			mation that frequency predictions were in
			error by 614 c/s at doppler mixer output.
1825 to 0240, GM-7		1825	Capsule lock for 1 minute.
		1828	Capsule lock for 3 minutes.

*Approximate time read from prediction data.

**See Space Flight Operations Memorandum Ranger 5, JPL Engineering Planning Document 133.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 21/1825 to 22/0240

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1825 to 0240, GM-7	-154	1829	
		1832	Capsule lock for 30 seconds.
	-149.5	1834	Capsule lock for 6 minutes with occasional
			dropout.
		1842	Capsule lock for 1 minute.
	-154	1844	Capsule lock for 1 minute.
		1847	Capsule lock for 2 minutes.
	-149.5	1848	
		1851	Capsule lock for 50 seconds.
	-153.5	1853	Capsule lock for 7 minutes with occasional
			dropouts.
	-147.5	1858	
		1902	Capsule lock for 6 minutes with occasional
			dropouts.
	-154	1903	
	-159	1911	Capsule lock for 8 minutes with occasional
			dropouts.
	-154	1912	
	-153	1921	Capsule lock for 7 minutes with several
			dropouts.
		1934	Capsule lock for 110 seconds.
		1941	Capsule lock for 6 minutes with occasional
			dropouts.
	-157.5	1942	
	-151	1944	
		1949	Capsule lock for 7 minutes with several
			dropouts.
	-158.5	1952	
	-149	2000	Capsule lock for 6 minutes with occasional
			dropouts.
	-154	2003	
		2009	Capsule lock for 6 minutes with several
			dropouts.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 21/1825 to 22/0240

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1825 to 0240, GM-7	-150.5	2011	
	-148	2013	
		2017	Capsule lock for 1 minute.
		2019	Capsule lock for 6 minutes with several
			dropouts.
		2020	One reel of 1 sample per second data found
			to be incorrectly punched.
	-149.5	2022	
		2029	Capsule lock for 6 minutes with several
			dropouts.
	-153.5	2039	
		2036	Capsule lock for 8 minutes with occasional
			dropouts.
	-149.5	2039	
		2047	Capsule lock for 6 minutes with occasional
			dropouts.
	-155	2100	
		2107	Capsule lock for 6 minutes with several
			dropouts.
	-149.5	2110	
		2115	Capsule lock for 7 minutes without dropouts.
			This was achieved by leaving the antenna in
			aided track and indicates that the servo iso
			amp gains were set too low so that good auto-
			track (consistent with the low signal level) was
			not possible. This incorrect procedure con-
			tinued throughout most of the remainder of
			the pass.
	-149.5	2117	
		2124	Capsule lock for 7 minutes without dropouts.
	-150	2127	
		2135	Capsule lock for 2 minutes.
		2137	Capsule lock for 7 minutes.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 21/1825 to 22/0240

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1825 to 0240, GM-7	-153.5	2138	
		2143	Capsule lock for 3 minutes.
		2147	Capsule lock for 3 minutes.
	-149	2148	
		2152	Capsule lock for 9 minutes with several
			dropouts.
	-151	2157	
		2203	Capsule lock for 6 minutes.
	-151	2205	
		2212	Capsule lock for 6 minutes.
	-155	2223	Capsule lock for 5 minutes with occasional
			dropouts.
		2231	Capsule lock for 7 minutes with occasional
			dropouts.
	-152	2233	
	-154	2242	Capsule lock for 7 minutes with several
			dropouts.
	-151	2244	
	-150	2252	Capsule lock for 5 minutes.
	-154	2310	Capsule lock for 16 minutes with several
			dropouts.
	-154	2320	Gertsch out of lock for 1 minute.
		2328	Capsule lock for 6 minutes with many dropouts.
	-154	2330	Gertsch out of lock for 2 minutes.
	-155	2338	Capsule lock for 7 minutes.
		2347	Capsule lock for 6 minutes with occasional
			dropouts.
	-153	2358	Capsule lock for 6 minutes with some dropouts.
	-152	0006	Capsule lock for 8 minutes.
	-158	0016	Capsule lock for 6 minutes with many dropouts.
	-154	0026	Capsule lock for 6 minutes.
	-154	0035	Capsule lock for 6 minutes.

Table A-5. (Cont'd)

STATION: DSIF-4

VIEW PERIOD: Oct. 21/1825 to 22/0240

Servo Bandwidth 0.025 cps

Receiver Bandwidth 20 cps

AGC Time Constant 10 sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1825 to 0240, GM-7		0044	Capsule lock for 3 minutes with occasional
			dropouts.
		0048	Capsule lock for 3 minutes.
		0054	Capsule lock for 16 minutes with dropouts.
	-154	0108	
		0114	Capsule lock for 5 minutes.
		0122	Capsule lock for 7 minutes.
	-158	0132	Capsule lock for 6 minutes with several
			dropouts.
	-154	0142	Capsule lock for 6 minutes with occasional
			dropouts.
		0151	Capsule lock for 2 minutes.
		0155	Capsule lock for 2 minutes.
		0201	Capsule lock for 5 minutes with occasional
			dropouts.
		0210	Capsule lock for 7 minutes. Servo iso amp
			gain correctly set. Angle data good.
	-158	0211	
		0219	Capsule lock for 7 minutes, with several
			dropouts.
	-156	0230	Capsule lock for 2 minutes.
		0233	Capsule lock for 3 minutes with occasional
			dropouts.
		0240	Track terminated.

Table A-5. (Cont'd)

STATION: DSIF-5

VIEW PERIOD: Oct. 22/0612 to 22/0730

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0300	Countdown commenced.
		0330	Intra-site communications completed.
		0430	Receiver checks completed.
		0430	Instrumentation checks completed.
		0430	Data checks completed.
		053130	Recorder on, started sampling servo to
			acq. pt.
(A)	-155.0	061205	Receiver in lock on capsule signal. Servo in
			auto.
		0730	End of track as scheduled. Receiver in and
			out of lock throughout tracking. Signal levels
			-151 to -155 dbm.
			Sent station summary.

(A) 0612 to 0730, GM-7 (intermittently)

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 22/1910 to 22/2015

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		1100	Equipment warm-up precalibration checks
			start for Ranger 5 and Mariner II Pass 57.
			Spacecraft above antenna limits at 0945*.
			Note:
			1. No predicts - servo operate in aided track.
			2. Data will sample at once per 10 seconds
			and send on teletype in real time.
			3. Doppler mode - nondestruct.
			4. Track capsule for AGC level and pointing
			information.
		1318	Going on Moon. Dec. 14.828.
		1340	Telemetry on. Searching for capsule.
		1350	Moon HA 334.038, Dec 014.832 (sunlit side
			of Moon).
		1355	Searching for capsule, moving antenna
			around point 2 degrees less in HA than Moon.
		1430	Checking position of Moon. HA 344.130 degrees
			@ 143100Z Dec 14.736 degrees.
		143230	Stopped antenna at 343.572 HA, 14.736 Dec.
		152000	Not able to find signal. Data and telemetry
			off going to Mariner.
		190000	Quitting Mariner going to Ranger 5.
		190330	Antenna on predicts HA, +0.2 degree Dec.
			Receiver searching for capsule.
			Data is preparing to sample with one machine
			at once/second, store and sample with other
			machine at once/10 seconds and send in real
			time to Lab. Instrumentation is changing
			Ampex recorders for Ranger 5.
1910 to 2015, GM-7 (intermittently)	-159	190940	RF lock. 10-second AGC time constant.
		191000	Sanborn on.
		191100	Data on. Ampex recorders on.
		191350	Signal strength fluctuating near threshold.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 22/1910 to 22/2015

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1910 to 2015, GM-7 (intermittently)		1923	Fluctuating near threshold - bad data.
		192428	Good data.
		193140	Near threshold.
		193208	Bad data.
		193414	Good data.
		1935	Channel 2 telemetry discriminator in lock.
		193508	Good-bad data switch to bad approximately
			20 seconds.
		194106	Out of lock. Bad data switch.
		194332	In lock. Good data switch.
		194638	Bad data.
		194710	Good data.
		195120	Bad data.
		195822	Good data. In lock.
		1959	Out of lock. Bad data.
		200346	In lock.
		200508	Out of lock.
		200628	In lock.
		200840	Out of lock.
		201248	In lock.
		201400	Out of lock.
		201500	In lock. Terminate Ranger 5 track.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 23/1309 to 23/1500

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		100000	Equipment on. Initial checks start.
		1035	Spacecraft above land mask*. Tracking
			scheduled from 1300 to 1500.
		1305	Calibrations complete.
		130930	RF lock.
		131446	Servo in slave. Offsets HA +0330, Dec
			+0360.
		131538	Out of lock.
		131838	In lock.
		132440	Servo in aided. Computer has wrong program
			and is resetting the program - no change noted
			in tracking commands.
1309 to 1500,		132536	Out of lock.
GM-7		132827	In lock. Servo in slave.
(intermittently)		1332	In aided. Bad commands from computer.
		134629	In lock after two brief out-of-lock periods.
	-159	134700	
		134850	Out of lock.
	-160.5	134910	In lock.
		135208	Out of lock.
	-163	135541	In lock.
		135753	Out of lock.
		135834	In lock.
	-158.7	135940	
		140117	Near threshold. Bad data.
		140444	Good data.
	-158.2	140600	
		140700	In slave. Commands good. HA +0330,
			Dec +0360.
	-159.2	1458	
1305 to 1531,	-157	1435	Servo maximized HA +0670, Dec 10360 in
GM-7			aided track.
(intermittently)		143900	In slave.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 23/1309 to 23/1500

Servo Bandwidth ________ cps

Receiver Bandwidth ________ cps

AGC Time Constant ________ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
1305 to 1531		150031	Good data. End Ranger 5 track. Occasional
GM-7			bad data periods of 1-minute duration
(intermittently)			occurred after 1406.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 24/1431 to 24/1455

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0930	"A" shift on duty, equipment on, initial checks
			start.
		0950	Maser being filled.
		1050	Maser having trouble due to faulty transfer
			tubes.
		1100	Spacecraft above land mask*. Tracking
			scheduled from 1200 to 1400.
		1300	All checks complete except AGC calibration
			trying to locate Venus transfer tube.
		1415	Maser filled with Venus transfer tube.
		1415	Abbreviated AGC calibration started.
		1431	AGC calibration complete.
↑	-160	143120	Receiver in lock. Tracking in aided -
			computer on Mariner II.
		143206	Good data.
1431 to 1455,		143230	Telemetry data on.
GM-7		143826	Out of lock. Bad data.
(intermittently)		144018	In lock. Good data.
		144750	Out of lock. Bad data.
		145056	In lock. Good data.
↓		1455	Terminate Ranger 5 track.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 25/1233 to 25/1420

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0930	"A" crew on duty. Equipment on. Initial
			checks start.
		1125	Spacecraft above land mask*. Tracking
			scheduled from 1230 to 1430.
		1228	All calibrations complete. Servo in slave.
			Offsets HA +0600, Dec +0330.
		1230	Instrumentation on. Receiver searching for
			capsule.
		123318	RF lock. 10-second. AGC time constant.
		123513	Good data.
		123812	Receiver out of lock. Bad data.
		124236	Receiver in lock.
		124245	Good data.
		124730	Receiver out of lock. Bad data.
		125122	Receiver in lock. Good data.
	-161	1254	
1233 to 1420,	-161.5	130114	
GM-7	-163.7	130130	
(intermittently)		131200	Receiver out of lock. Two out-of-lock periods
			have occurred since 1254.
		131220	Bad data.
		131310	Receiver in lock. Good data.
		132341	Receiver switched to 300-second AGC time
			constant.
		141710	Out of lock. Bad data.
		141826	In lock. Good data.
		142000	Terminate Ranger 5 track. Receiver
			experienced occasional out-of-lock periods
			throughout the tracking period.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 26/1202 to 26/1400

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0930	"A" and "C" crew on duty. Equipment on.
			Initial checks start.
		1140	Spacecraft above land mask*. Tracking
			scheduled from 1200 to 1400.
		1157	Calibration complete.
		1200	Instr. on. Not taking Ampex.
1201 to 1400, GM-7 (intermittently)		120134	RF lock. 10-second AGC time constant.
			20-second bandwidth.
		120200	Data on.
		120303	Receiver out of lock.
	-166	121120	Receiver going in- and out-of-lock.
	-166	1217	Out-of-lock periods are 1 to 5 minutes
	-165	1226	duration. In-lock periods are 1/2 to 6 minutes
	-168	1227	duration.
	-163.5	1245	
	-162	1247	
	-161.75	124740	
	-168	1257	
		1307	Doppler loop out of lock about 2 minutes.
		1308	Doppler loop out of lock 15 seconds.
		131150	Doppler loop out of lock 10 seconds.
	-167	1316	
	-167	1322	
	-168	134120	
	-162	134220	
	-160	1352	
		1359	Out of lock.
		1400	End of track. In- and out-of-lock conditions
			continued until the end of the tracking period.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2 **Servo Bandwidth** _____ cps

VIEW PERIOD: Oct. 27/1158 to 27/1340 **Receiver Bandwidth** _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0930	Equipment warm up and initial checks.
		1048	Receiver and instrumentation completed
			static phase error checks.
		1052	Receiver and instrumentation completed
			dynamic phase error checks.
		1122	Receiver and instrumentation completed
			AGC calibration.
		1128	Receiver and data completed data condition
			checks.
		1130	Servo on point. Receiver searching for
			capsule.
		1138	Telemetry on.
		1142	Servo in slave.
1158 to 1340, GM-7 (intermittently)		1150	Spacecraft above land mask*.
		115813	Receiver in lock. Good data. Tracking
			scheduled until 1330.
		115820	Data on.
		115855	Receiver out of lock.
		120030	Receiver in lock.
	-167	1202	
	-165.5	122000	
	-166	122630	
	-167.5	130230	
	-167	130535	
	-167	133220	
		134000	End of Ranger 5 track. Receiver was in- and
			out-of-lock throughout the tracking period.

*Time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 28/1233 to 28/1409

Servo Bandwidth _____ cps

Receiver Bandwidth _____ cps

AGC Time Constant _____ sec

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		093000	Equipment warm up.
		1000	Intermittent failure in the secondary punch
			logic (10-second sample rate).
		1155	Spacecraft above land mask*. Tracking
			scheduled from 1200 to 1400.
		1200	Calibration complete.
↑	-168	1233	First solid lock.
		1235	Out of lock.
1233 to 1409,	-167	1241	
GM-7	-165	1244	
(intermittently)		140837	Out of lock. End of Ranger track. Receiver
			was in- and out-of-lock throughout the entire
↓			tracking period.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 29/1247 to 29/1400

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0930	Equipment on. "A" crew on duty. Initial
			checks start.
		1130	Initial checks complete.
		1205	Spacecraft above land mask*. Tracking
			scheduled from 1200 to 1400.
		1225	Receiver and instrumentation AGC checks
			complete. Servo in slave. Instrumentation
			making final checks.
		122900	Instrumentation on.
		123100	Data on.
↑		124722	
		124812	
		124832	
		125012	Momentary receiver lock. Not long enough
		125132	for good doppler readings as yet. Signal
		125202	strength varying around threshold.
		125912	
1247 to 1400,		125942	
GM-7		130022	
(intermittently)		130600	Good-bad data switch will be left in the good
			position for rest of track so as to get the
			maximum number of good doppler samples
			during the short time receiver is in lock.
			(Authorized by Test Director).
		1400	End track last observed ref. VCO freq.
			31.000526. Signal strength varied at and
↓			above -169 dbm.

*Approximate time read from prediction data.

Table A-5. (Cont'd)

STATION: DSIF-2

VIEW PERIOD: Oct. 30/1200 to 30/1325 (Search Period)

Servo Bandwidth _____ **cps**

Receiver Bandwidth _____ **cps**

AGC Time Constant _____ **sec**

Tracking Conditions	Sig Str (dbm)	Time (GMT)	Remarks
		0930	"A" crew on duty. Equipment was left on.
		1043	AGC calibration start.
		1100	AGC calibration complete.
		1200	Antenna on point. Instrumentation on.
		120950	Servo in slave. Offsets HA +0700, Dec
			+0500. AGC TC 10-second 20 cycle BW.
		1210	Spacecraft above land mask*. Tracking
			scheduled until 1400.
		1230	Data on.
		1256	Switched to 300-second AGC time constant.
		1306	Switched to 10-second AGC time constant.
		1325	Not able to detect signal end track. Station
			secured from Ranger 5 mission.

*Approximate time read from prediction data.

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